NASA

REPORT NO. CASD-NAS-74-046
CONTRACT NAS 8-30288

(NASA-CR-12?453) LIFE SCIENCES PAYLOAD DEFINITION AND INTEGRATION STUDY. VOLUME 3: PRELIMINARY EQUIPMENT ITEM SPECIFICATION (General Dynamics/Convair) 159 p HC $11.?? CSCL 22A G3/31 N74-34312 Unclas 47578

LIFE SCIENCES PAYLOAD DEFINITION AND INTEGRATION STUDY

VOLUME III ◆ PRELIMINARY EQUIPMENT ITEM SPECIFICATION CATALOG FOR THE CARRY-ON LABORATORIES

GENERAL DYNAMICS
Convair Division

REPORT NO. CASD-NAS-74-046

LIFE SCIENCES PAYLOAD DEFINITION AND INTEGRATION STUDY

VOLUME III ✦ PRELIMINARY EQUIPMENT ITEM SPECIFICATION CATALOG FOR THE CARRY-ON LABORATORIES

August 1974

Submitted to
National Aeronautics and Space Administration
GEORGE C. MARSHALL SPACE FLIGHT CENTER
Huntsville, Alabama

Prepared Under
Contract NAS8-30288

Prepared by
GENERAL DYNAMICS CONVAIR DIVISION
P.O. Box. 80847
San Diego, California 92138

ACKNOWLEDGMENTS

The authors wish to express their appreciation to the entire Life Sciences Payload Integration Team composed of:

C. B. May, Contracting Officer's Representative, NASA/MSFC

R. W. Dunning	NASA/Headquarters
S. T. Taketa	NASA/Ames Research Center
J. A. Mason	NASA/Johnson Space Center

and to J. D. Hilchey, NASA/Marshall Space Flight Center, for their valuable assistance and cooperation throughout the entire course of this study.

The following Convair personnel contributed to this program:

G. L. Drake (Contract Manager)
R. C. Armstrong, M.D. (Convair Life Sciences Manager)
F. W. Anding
R. E. Bradley
F. G. Rivinius
E. J. Russ
W. G. Thomson

Comments or requests for additional information should be directed to:

C. B. May
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, Alabama 35812
Telephone: (205) 453-3431

or

G. L. Drake
Convair Division of General Dynamics
P.O. Box 80847, Mail Zone 663-00
San Diego, California 92138
Telephone: (714) 277-8900, Ext. 1881

PRELIMINARY EQUIPMENT ITEM SPECIFICATION DATA

All general purpose equipment items (E.I.s) contained in the final COL concepts are described in this volume. The final COL concepts were described in Section 4 of Volume II and included Category A, B and C laboratories, all of different size ranges. All E.I.s contained within the Category A, B and C COLs are described herein under the same name and E.I. number which was listed in Volume II.

All the E.I.s contained herein are described according to a standard specification sheet format, and are listed alphabetically by name. The specification format includes the following headings and information as discussed below.

1. <u>Equipment Item Number and Name</u>

   The E.I. number was taken fromthe original equipment inventory developed during the preceding Life Sciences Payload Definition and Integration Study[1]. Thus, the number preserves the traceability of the E.I.s in the COLs to the original larger capacity equipment intended for larger laboratories. To distinguish between the original equipment and the COL equipment which is usually smaller, lighter, and simpler in nature, a C has been placed before the original E.I. number. The COL also contains E.I.s not required in the previous inventory. These items have been assigned new numbers beginning at C188 and increasing.

2. <u>Purpose</u> (of E.I.)

   The general reason why each E.I. is needed in the COLs is stated under this heading.

[1]Life Sciences Payload Definition and Integration Study, Report No. GDC-DBD72-002, Contract NAS8-26468, General Dynamics, Convair Aerospace Division, San Diego, CA, March 1972.

3. <u>Requirements</u>

If specific requirements of the equipment are known, they are stated. However, often the specific requirements are unknown. This is to be expected since this study is in the conceptual phase and the facility approach to COL definition was being used, wherein specific experiments were not being used as design criteria. The specification sheets contained herein represent working papers to be continually updated as COL life sciences definition activity continues. Hence, as specific requirements become known, they can be entered.

4. <u>Hardware Status</u>

Under this heading, the development status of the E.I. is described, including statements as to the suitability of using commercially available equipment in the zero-g space environment.

5. <u>Technical Description</u>

Estimates of weight, power, and volume for flight-type equipment are included under this heading as well as any other descriptive technical data of significance.

6. <u>Cost</u>

Estimated development and unit costs for the E.I.s are included, based upon the cost analysis presented in Section 6 of Volume II. When available, a typical commercial unit cost is also listed for a commercial item similar in nature to the flight item required in the COL.

7. <u>Development Time</u>

The time to develop flight-qualified equipment is estimated for each E.I.

In addition to the information contained under the headings listed above, additional information is often included for the E.I.s in the form of catalog sheets, pictures, specification sheets, etc., taken from miscellaneous sources.

A summary list of all the E.I.s described in this volume is shown in Table 1. The list includes the E.I. number, name, weight, volume, and power. In addition, the FPEs which require each E.I. are indicated by an "X" in the table.

Table 1. Summary of Equipment Items Contained in This Volume
(E.I. Number, E.I. Name, Using FPEs, Weight, Volume, & Power)

	EQUIPMENT ITEM	BIO MED	SML VER	C/T	INV	PLT	MSI	LS PS	WT LB	VOL FT3	POW W
C6	AIR PARTICLE SAMPLER	X	X	X	X	X			6	0.03	50
C14	ANESTHETIZER				X				1	0.04	0
C166	AUTO. POTEN. ELECTROLYTE ANALYZER	X	X						28	4.63	100
C65	BLOOD GAS ANALYZER	X	X						18	1.6	55
C189	BLOOD SAMPLE PROCESSOR CENTRIFUGE	X	X						28	0.88	100
C30A	CAGE, SMALL VERTEBRATES (BREGD.)		X						5	0.39	9
C32	CAMERA, CINE							X	11	0.18	13
C37	CAMERA, VIDEO, BLACK/WHITE							X	10	0.11	15
C38	CAMERA, VIDEO, COLOR	X	X	X	X	X	X		17	0.22	69
C34	CAMERA, 35MM	X	X	X	X		X	X	4	0.07	0
C190	CAMERA MOUNTS						X		7	0.1	0
C191	CAMERA TIMER, VIDEO						X		9	0.11	10
C50	CLINOSTAT					X			7	0.71	10
C54	COLONY COUNTER			X	X	X			3	0.05	50
C99	COMMON HOLDING UNIT	(PART OF HOLDING UNIT E.I.'S)							45	6.64	50
C156	COUPLERS	X	X						5	0.20	24
C55A	CREW MOBILITY AIDS	X	X	X	X	X	X	X	5	0.1	0
C55B	CREW RESTRAINTS	X	X	X	X	X	X	X	9	0.35	0
C192	DISPLAY, NUMERIC	X	X	X	X	X		X	4	0.14	2
C167	HOFT STORAGE CONTAINER (ROOM TEMP)	X	X	X	X	X			1	0.11	0
C196	EQUIPMENT RESTRAINTS	X	X	X	X	X	X	X	1	0.04	0
C72C	FILM, CINE							X	5	0.08	0
C167C	FILM CABINET							X	20	0.32	0
C197	FLOWMETERS							X	4	0.07	4
C60	FREEZER, GENERAL	X	X	X	X	X			15	0.53	50
C61	FREEZER, LOW TEMPERATURE	X	X	X	X	X			15	0.53	400
C69	GAS CHROMATOGRAPH							X	22	0.71	50
C93A	GAS SUPPLY VESSELS							X	26	1.26	0
C98A	HOLDING UNIT, C/T			X					50	5.64	50
C98C	HOLDING UNIT, INV.				X				50	6.64	50
C101	HOLDING UNIT, PLANTS					X			55	6.64	500
C103	HOLDING UNIT, SM. VERT.		X						30	6.64	0
C193	INCUBATOR, 37C (MINI)	X	X	X	X				11	0.26	5
C199	INFRARED GAS ANALYZER							X	25	1.51	50
C200	KIT, ANIMAL PHYSIOLOGY		X						3	0.07	0
C210	KIT, BLOOD ACQUISITION	X							3	0.11	0
C201	KIT, CHEMICAL SAMPLING							X	3	0.18	0
C106A	KIT, CLEAN-UP	X	X	X	X	X		X	3	0.18	0
C113	KIT, GENERAL TOOL	X	X	X	X	X	X	X	10	0.5	50
C106	KIT, HEMATOLOGY	X	X						9	0.21	0
C106	KIT, HISTOLOGY		X		X	X			2	0.04	0
T110C	KIT, HUMAN PHYSIOLOGY	X							7	0.28	0
C110	KIT, MICROBIOLOGY	X	X	X	X	X			4	0.11	0
C114A	KIT, MICRODISSECTION		X	X	X	X			2	0.07	0
C211	KIT, PHYSICAL EXAMINATION	X							3	0.11	0
C111	KIT, PLANT MANAGEMENT					X			2	0.04	0
C212	KIT, URINE ACQUISITION	X							2	0.11	0
C110B	KIT, VERTEBRATE MANAGEMENT		X						7	0.21	0
C202	LAMP, PORTABLE HI INT. PHOTO	X	X				X	X	14	0.21	150
C203	LIQUID TANK (WET WT.)							X	36	0.58	0
C116	LOG BOOKS	X	X	X	X	X	X	X	1	0.01	0
C122	MASS MEASUREMENT DEVICE							X	35	0.71	7
C91	MASS SPECTROMETER		X	X	X	X		X	25	0.53	30
C126B	MICROPHONE						X		1	0.02	0
C126	MICROSCOPE, COMPD		X	X	X	X			25	1.0	50
C126A	MICROSCOPE, DISSECTING		X	X	X	X			20	1.0	63
C203A	OCULOGYRAL ILLUSION BOX	X							1	0.04	0
C132	OSCILLOSCOPE (BATTERY POWERED)	X	X						4	0.09	0
C136	PH METER			X		X			4	0.18	20
C204	PLUMBING							X	22	0.21	0
C149	RADIOISOTOPE TRACERS	X	X		X	X			1	0.02	0
C205	RECORDER, STRIP CHART (BATT. POW.)							X	31	0.60	0
C153	RECORDER, VOICE (BATT. POW.)	X	X					X	2	0.04	0
C63	REFRIGERATOR	X	X	X	X	X		X	11	0.63	15
C155	SENSORS, MISCELLANEOUS	X	X	X	X	X		X	4	0.07	4
C206	SHROUD, DEBRIS CONTAINMENT		X	X	X	X			10	10.6	0
C155A	SHROUD, ENVIRONMENTAL							X	10	0.2	0
C165	STERILIZER, TOOL (BACTECINERATOR)	X	X	X	X	X			2	0.04	110
C177	TEMPERATURE PROBES	X	X	X	X	X		X	1	0.01	0
C160	TIMER, EVENT	X	X	X	X	X	X	X	1	0.01	0
C40	VACUUM CLEANER		X	X	X	X		X	5	0.35	100
C116	VACUUM MANIFOLD							X	20	1.0	0
C195	VENTILATION UNIT, SMALL VERT.		X						21	0.67	40
C176	VIDEO TAPE						X		11	0.13	0
C207	VIDEO TAPE RECORDER						X		49	1.8	80
C135	VOLT-OHMMETER (VOM), (BATT. POW.)							X	5	0.08	0
C213	WASTE STORAGE BAG	X							1	0.26	0
C109A	WASTE STORAGE CONTAINER	X	X	X	X	X		X	2	1.0	0
C174	WATER TANK, ORGANISM (WET WT.)		X			X			28	0.78	0
C208	WIRE AND CABLE	X	X						4	0.14	0
C209	WORK SURFACE, AIRFLOW	X	X	X	X	X			11	0.21	75

E.I. C6 - AIR PARTICLE SAMPLER

Purpose

To obtain air particle and micro-organism samples for air quality determinations. Such determinations are necessary for experiment control purposes.

Requirements

TBD.

Hardware Status

Commercial models are available which should be applicable to spacecraft use. A high flow rate model using filter paper for trapping the particles is shown in the attached catalog sheet. The blower motor may require replacement with a 28 volt d.c. motor, and the unit flow rate would probably be reduced for COL purposes.

An alternate type of air sampler is the Anderson type of sampler which contains a series of agar-coated petri dishes on which the air flow impinges. Particles and bacteria stick to these dishes and can subsequently be analyzed. The unit described in the attached catalog sheet could possibly be adapted to this mode of particulate capture, if desirable.

Technical Description

Estimated properties of a flight type air particle sample collector are:

Weight	2.72 kg (6 lb)
Volume	0.85 dm^3 (0.03 ft^3)
Power	50 watts

Cost

Estimated costs are:

Development	$11K
Unit	$1K

The commercial unit cost is $0.2K.

Development Time

< 1 yr.

Air Sampler

10290–009

10290–009 AIR SAMPLER, Hi-Volume, Staplex — For accurately sampling large volumes of air for particulate matter by means of various types of filter paper. A basic instrument in helping combat and control air pollution. Excellent for both indoor and outdoor sampling. Being used to determine factory health hazards, atmospheric conditions, smoke abatement, smog, for mine inspections, etc. Accurately samples air containing particles as small as 1/100 of a micron in diameter.

The aluminum filter holder accommodates both pleated and flat papers, of which three types are available. Extra interchangeable filter holders are available also. The pump and motor air-mover is a high speed, heavy duty turbine type designed for 24 hour sampling. The fan housing assembly is of cast aluminum. The rate of flow is measured by a variable orifice meter. Portable, field weight 10 lbs. For 115 volts 25/60 Hz.

Each 146.50

Air Filters

10291–001 FILTER PAPER for above — Delivers approximately 18 CFM. Box of 100.

Box 12.60

10292–004 FILTER PAPER for above — Delivers approximately 36 CFM. Box of 100.

Box 20.95

10293–007 FILTER PAPER for above — Pleated. Delivers approximately 70 CFM

Lot of 3 2.40

E.I. C14 - ANESTHETIZER, INVERTEBRATES

Purpose

This device will be used to render invertebrate organisms (such as vinegar gnats) insensible in order to facilitate handling.

Requirements

1. Use of CO_2 system preferred due to safety and compatibility with the crew EC/LSS
2. CO_2 concentration required: 90%.
3. Maximum capacity: Assume 6,000 cc/day. (This will approximately anesthetize organisms in 6-500 cc containers, assuming 2 effective air volume purges to reach 90% CO_2.)

Hardware Status

This item involves the use of a standard gas bottle, valve and plumbing components. These components will not require major modification. Commercial hardware should be usable.

Technical Description

One simple design would utilize a CO_2 bottle, a valve, and connecting tubing. The critical temperature of CO_2 is 88.4°F and since the storage vessel could conceivably reach this temperature, supercritical storage conditions were assumed in estimating the storage vessel properties below.

	7 Days	30 Days
CO_2 weight:	83 g (0.18 lb)	354 g (0.78 lb)
Total weight (including storage vessel & plumbing)	187 g (0.41 lb)	797 g (1.76 lb)
Power	Negl.	Negl.
Volume of CO_2 bottle (including 20% of CO_2 volume for bottle volume)	0.5 dm (0.02 ft^3)	2.12 dm^3 (0.07 ft^3)
Storage bottle pressure	10.3 mN/m^2 (1500 psia)	
Total envelope volume estimate (including plumbing)	1 dm^3 (0.04 ft^3)	2.6 dm^3 (0.09 ft^3)

E.I. 014 ANESTHETIZER, INVERTEBRATES (Cont'd)

<u>Cost</u>

The estimated cost of flight type storage vessels, valves and plumbing is:

Development	$2K
Unit	$0.5K

<u>Development Time</u>: < 1 yr.

E.I. C188 AUTOMATED POTENTIOMETRIC ELECTROLYTE ANALYZER

Purpose

To measure gases and electrolytes in blood and urine sample

Requirements

This equipment item has been developed for NASA/JSC by Orion, Inc., especially for spaceflight use. The characteristics of this analyzer are presented below. No special requirements have been identified for COL use.

Hardware Status

A flight prototype of the automated potentiometric electrolyte analyzer is currently undergoing evaluation at NASA/JSC. The unit was constructed under NASA contract NAS9-12117.

Technical Description

This analyzer processes a 1 ml blood sample to measure pH, pCO_2, Na, K, Cl, ionized Ca and total Ca. A modified version is anticipated which will be capable of additional measurements of pO_2 and glucose. The prototype analyzer is comprised of 4 units. These are: (1) a teletype machine, (2) a Digital Equipment Corp. PDP-8E digital computer, (3) an electronics unit, and (4) a fluid transport unit. In flight, the capability provided by the teletype and the digital computer can be provided by the supporting spacecraft control and data management subsystem digital readouts and computer. The electronics unit can also be drastically reduced in size and integrated with the fluid transport unit. Characteristics of the resulting flight unit are estimated below:

Weight:	12.7 kg (28.0 lb)
Volume:	131 dm^3 (4.63 ft^3)
Power:	100 watts

The unit contains consumable reagents, reported to be about 2 liters for a total of 100 analyses. This number of analyses was assumed to be adequate for the COL requirements.

Cost

Estimated costs for the automated potentiometric electrolyte analyzer are:

Development:	0 (currently being developed)
Unit:	$70K

Development Time - 1 year.

E.I. C85 BLOOD GAS ANALYZER

Purpose

To determine the partial pressures of oxygen and carbon dioxide dissolved in blood samples and to determine the hydrogen ion concentration.

Requirements

Unspecified. (Capabilities of a commercial unit are given under "Technical Description.")

Hardware Status

Present systems use gravity to preclude air entrainment in the sample so special fluid handling techniques must be applied. Equipment would have to be modified if power other than 115 volt, 60 Hz were used.

Technical Description (Instrumentation Laboratory Model IL 313)

	Commercial Model		Flight Unit - Preliminary Estimate
Weight	13.6 kg (30 lb) (est.)		8.2 kg (18 lb)*
Volume	85 dm^3 (3 ft^3) (est.)		45.3 dm^3 (1.6 cu. ft.)
Power	100 watts (est.)		55 watts
Ranges	pH	6.000 to 8.000	*Including O_2 & CO_2 calibration gases and their containers which weigh 0.2 kg/wk.
	P_{CO_2}	0 to 200 mm Hg	
	P_{O_2}	0 to 2000 mm Hg	
Precision	pH	± .003 pH	
	P_{CO_2}	± 0.5 mm Hg	
	P_{O_2}	± 1 mm Hg at 200 $P_{O_\pm}$	
		± 10 mm Hg at 2000 P_{O_2}	

E.I. C85 BLOOD GAS ANALYZER (Cont'd)

Cost

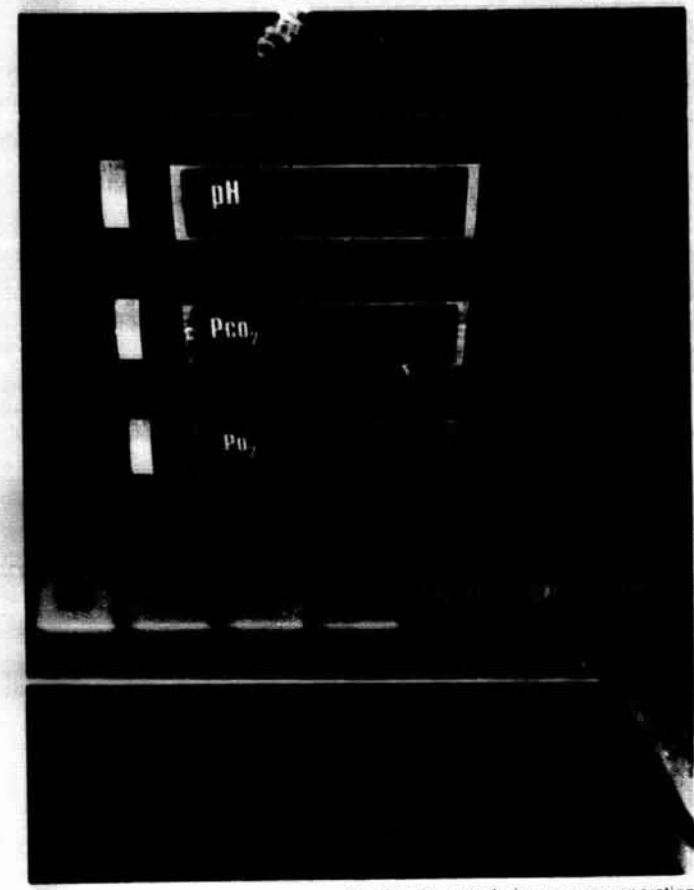
Development:	$240K
Unit:	$64K
Commercial:	$5.3K

Development Time: One year.

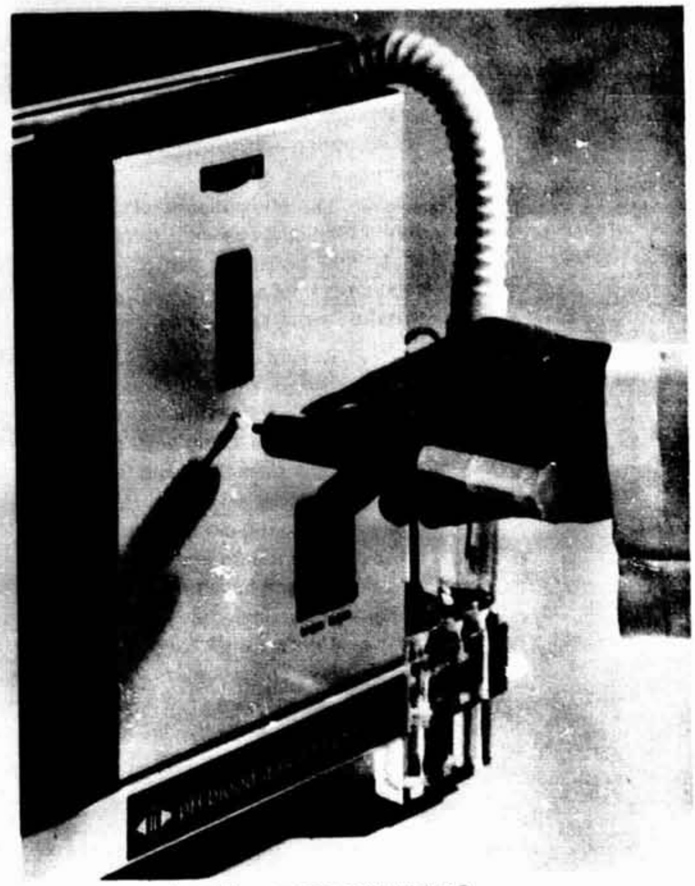
Comments

For basic principles of operation and logistics, see Allen C. Norton, Ph.D., "Survey of Commercial Laboratory Instruments for Space Station Application," Volume II, Beckman Instruments, Inc., FR-1065-101, October 31, 1970.

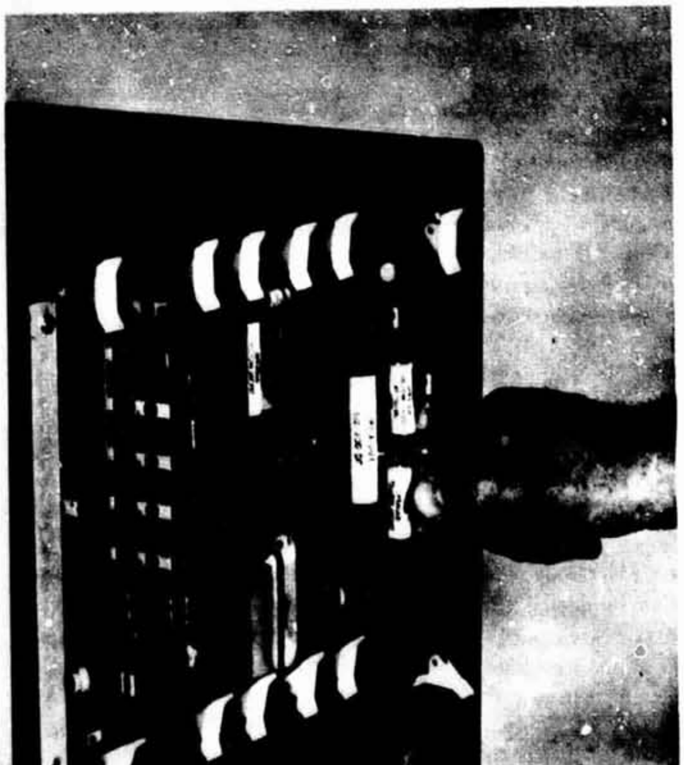
E.I. C85 BLOOD GAS ANALYZER (CONT.)



Tip-Touch controls insure easy operation



Sample port accepts capillary, syringe or Vacutainer®



Modular "plug-in" electronics simplify maintenance checks

Positive "no loss" handling of ultra-micro samples

cooling system in the bath permits its operation up to ambient temperatures of 35°C. Electromagnetic coupling of the water pump eliminates sealing problems and a new peristaltic pump mechanism insures correct vacuum pressure at all times.

Simplified Maintenance
Modular plug-in construction of the electronics measurably aids in reducing any possible down time or service expense. All mechanical parts in the automatic gas calibration, sample presentation and cuvette cleaning system have been carefully chosen for maximum life under the most demanding work loads. The tubing has been specially selected for trouble-free durability. Readily removable covers on the 313's cabinet make maintenance checks fast and simple. Stainless steel is used in all areas where corrosive material can come into contact with the unit.

Electrical Characteristics
The Model 313 is a universal voltage instrument. It can be adjusted to operate from 80 volts, 50 60 Hz to 280 volts, 50 60 Hz. Nominal operating power is 120V (±20%), 60 Hz. Special circuits compensate for line transients. Analog output is standard. Digital binary coded decimal output with computer data ready signals is optional and can be field installed. Circuitry is integrated, plug in and totally solid state. Optional printer and recorder readouts are available.

Advantages to the Laboratory
Clinician, laboratory technician and engineer have joined together to provide a system which simplifies and automates pH/Blood Gas Analysis. The IL Model 313 was designed so that its operation is easily taught and even relatively inexperienced laboratory personnel can readily operate it. Precision is enhanced by the development of a systematic sample handling system. Speed of measurement is insured by special circuits coupled to a display for the simultaneous readout of all three values. The time required for sample flushing and calibration has been appreciably lessened by an automatic cleaning cycle which does not require attention. Maintenance has been simplified by the use of plug-in modules and magnetic cabinet fasteners. Solid-state, space age electronics insure precision and long term reliability. The additions and changes have been developed after years of research and many clinical evaluations. They strictly adhere to the fundamental need in the laboratory for accuracy, speed and ease of operation. The automated Model 313 is the most advanced pH Blood Gas System available. As reflected in laboratory time and effort saved its value is immediately apparent.

Specifications
RANGE: pH 6.00 to 8.000, Pco_2 0 to 200 mmHg, Po_2 0 to 200 or 0 to 2000 mmHg
PRECISION: pH ± 0.003 pH, Pco_2 ± 0.5 mmHg Pco_2, Po_2 ± 1 mmHg 200 Po_2 or 10 mmHg 2000 Po_2.
REPEATABILITY (with electrodes): pH ± 0.005, Pco_2 1% of Pco_2 reading, Po_2 1% Full Scale Po_2.
SAMPLE: Typically whole blood or other body fluids including expired gases.
SAMPLE SIZE: Automatic 0.4 ml, Manual 0.2 ml.
READOUT: Simultaneous four decimal digital displays for each parameter.
COMPATIBLE OPERATING VOLTAGE & FREQUENCY: 120 Volts ± 20%, 50 60 Hz, 100 and 240 Volt instruments available.
OUTPUTS: Analog and Optional binary coded decimals.
TEMPERATURE RANGE: 36° to 38°C.
TEMPERATURE STABILITY: ± 0.05°C.

Digital pH/Blood Gas Analyzer

The IL Model 313 is an all new, automated system for faster, more precise blood parameter analysis. Oriented to the needs of the busy laboratory it has been specifically engineered to simplify and speed-up blood analyzing procedures. The instrument's wide range provides for both clinical and research usage. Automatic features allow even inexperienced personnel to get answers of the accuracy and precision that have been routinely obtained only with long experience. For the first time an operator can introduce a sample and within a minute read simultaneously the pH, Pco_2 and Po_2 values. A digital programmer sequentially controls introduction of calibrating gas, data presentation and automatic cuvette cleaning. Alternate sample presentation by capillary tube, Vacutainer® or syringe is made without need for instrument adjustment. Modular design of all major components simplifies maintenance.

Method of Operation

A precision pump draws the sample from the collection vessel into the blood gas measuring cuvette. Use of a specially designed measuring circuit speeds up read out time. Within 45 seconds a DATA light signals presentation of final results. All three values now can be read simultaneously on the Nixie® tube displays. Answers are held for one minute allowing ample time for recording. During this period the unit's digital programmer automatically starts a cleaning and gas calibration cycle. The sample is drawn from the cuvette and prewarmed cleaning solution pumped through the system. Temperature controlled, humidified calibrating gas follows and remains in the chamber for an immediate calibration check. From one sample to the next the entire procedure takes less than two minutes.

Useful Innovations

Among the many useful innovations that insure quick, accurate analyses is the programmed instrument sequence which systemizes gas calibration, sample presentation and cleaning operations. Before entering the measuring chamber all samples, calibrating gases and cleaning solutions are prewarmed to bath temperature. The chamber itself is lighted for quick observation during analysis. Signal lights on the front panel continuously monitor both the temperature of the cuvette and the integrity of the electrode membranes. Once the gas flow rate through the humidifiers has been set, it rarely requires adjustment. Positive protection against cross mixing of calibrating gases is provided, and a "GAS SAVER" stand-by position automatically insures gas flow only when it is required. Other innovations include lighted controls for a continuous indication of the function being performed by the 313 System, and a highly stable electronic circuit instead of a battery supplying polarizing voltage to the Po_2 electrode. Sample and the flushing solutions are pumped into any convenient drain.

New Features

Each measuring circuit is independent, and analog to digital converters are interchangeable. Pco_2 readings are made linearly, eliminating the need to ratio calibrating gases. A "STAND-BY" position maintains the Model 313 in constant readiness for immediate analysis of "stat" samples. The geometry of the new Pco_2 electrode has been engineered to insure minimum response time, improved washout and maximum precision. For greater stability both the pH and the Pco_2 electrodes are now supplied with coaxial connectors on short lead lengths. Redesign of the pH electrode assembly provides a quick, easy manual procedure for the extremely small sample. The internal

E.I. C189 BLOOD SAMPLE PROCESSOR CENTRIFUGE

Purpose

Centrifugation of human and vertebrate blood samples.

Requirements

The requirements of this item are similar to those of the existing centrifuge used on Skylab which centrifuges human blood samples of about 10 cc contained in special "blood sample processor" syringes. However, the carry-on laboratory centrifuge must be capable of centrifuging small blood samples from humans and small vertibrate organisms.

Hardware Status

This item is space qualified, but some modifications may be required. This may include a head modification for the purpose of accepting smaller samples.

Technical Description

The properties of the Skylab unit were used for carry-on laboratory conceptual design purposes. Its properties are:

Weight	12.7 kg (28 lb)
Head Diameter	3.3 dm (13 inches)
Power	100 w (peak, 28 volt d.c.)
Volume	25 dm^3 (0.88 ft^3), estimate
Speed	2600 rpm or 3000 rpm

Cost

Estimated flight item costs are:

Development	$10K
Unit	$10K

Development Time: < 1 yr.

E.I. C30A CAGE, SMALL VERTEBRATES

Purpose

To house single animals such as rats in either a zero-g or 1-g environment.

Requirements

The rat was used as the basis for the sizing of the small vertebrate cages. The required inside dimensions of the cage are approximately 22.9 cm long × 15.2 cm wide × 14 cm high (9" × 6" × 5.5"). The cage should have at least one of its six sides transparent and one side openable. It should also incorporate an orientation screen, waste capture filter, feeding device, watering device, provisions for air circulation, and provisions for organism instrumentation interconnections.

Hardware Status

Conceptual design item.

Technical Description

A cage designed by General Dynamics Convair Aerospace is shown in the attached picture. It was designed to fit into a cage module holding unit which accommodates 8 such cages. This cage was used as a basis for the weight, volume and power estimates below.

Weight:	2.3 kg (5.1 lb)
Outside Dimensions:	33 cm long × 16.5 cm wide × 20.3 cm high (13" × 6½" × 8")
Outside Volume:	11 dm^3 (0.39 ft^3)
Power:	9 watts (lights)

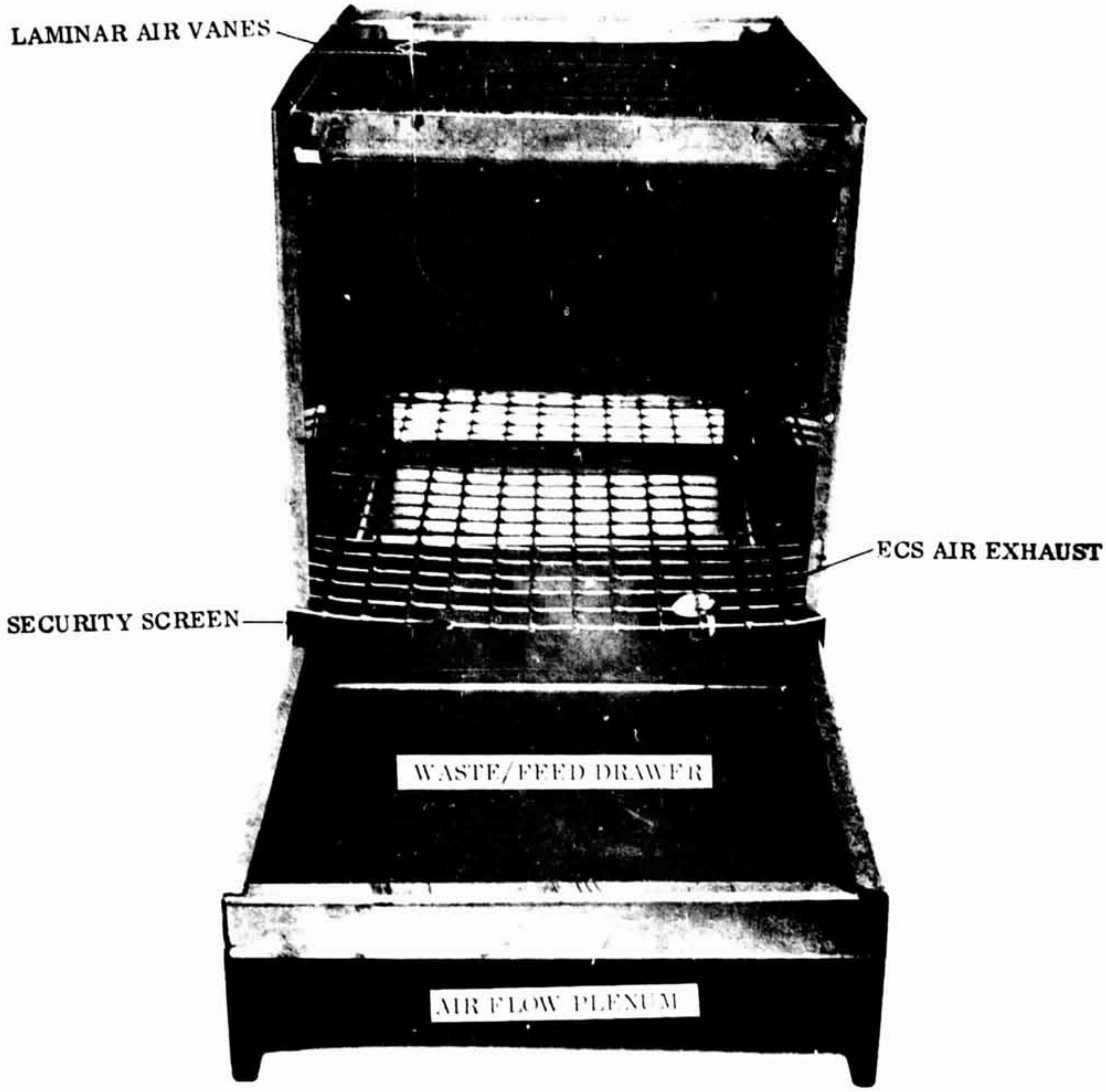
Cost

Estimated flight item costs are:

Development:	$224K
Unit:	$3.5K

Development Time

Two years in conjunction with the cage module holding unit.


LAMINAR AIR VANES
ECS AIR EXHAUST
SECURITY SCREEN
WASTE/FEED DRAWER
AIR FLOW PLENUM

RAT CAGE

E.I. C32 CAMERA, CINE

Purpose

To obtain motion picture records of various experiment events and phenomena.

Requirements

Specific requirements are yet to be determined. It is anticipated that a standard 16 mm camera with interchangeable lens would be adequate for use. Variable frame rates will probably be required, high frame rates (several hundred frames per second) for recording high speed physical phenomena and low frame rates (6/sec) for recording crew motions during crew/equipment interaction experiments. The Apollo cameras (described below) operate at 6 frames/second in order to minimize film weight. Standard commercial motion pictures are taken at 24 frames/second. Various accessories will be required such as camera mounts, lenses, lights, etc.

Hardware Status

Maurer model 308 cameras were used on the Apollo and Skylab flights and are assumed to be available from NASA-JSC (Flight Crew Support Division). These cameras operated at 6 frames/second, but might be modified for operation at higher frame rates.

A commercially available Beaulieu R16B Automatic by Cinema Beaulieu Corp. offers variable frame rate and battery powered operation and may be usable. It is a 16 mm camera, with electric drive, through the lens viewing and exposure control, variable speed from 2-64 frames/sec., pulse mode with external control, and various film magazines available. It will accept a wide variety of "C" mount lens systems, has rechargeable battery and sound synchronization. It would require modifications to the battery charger to allow it to operate on 28 VDC. The camera weighs 3.2-3.7 kg (7-8 lb), occupies 8 dm^3 (0.3 ft^3), and requires a maximum of 10 watts while charging its batteries.

Technical Description

A figure showing the Maurer model 308 data acquisition camera (DAC) with quick mount is shown on a subsequent page. This type of camera, including accessories, was assumed to be used in the carry-on laboratories (COLs). Accessories might include a universal camera quick mount, several optional lenses, remote control assembly, a short power cable, a portable high intensity photographic lamp (EI C202), light meter, optical ring sight, and film transport mechanism. The estimated total weight, power and volume of the equipment needed for the COL is:

E.I. C 32 CAMERA, CINE (Cont'd)

Weight	5 kg (11 lb)
Volume	5 dm^3 (0.18 ft^3)
Power	12.6 watts, average (28 VDC)
	22.6 watts, peak

The film cassettes for this camera which were used on Skylab contained 400 ft of film which provided about 45 minutes of filming. The approximate characteristics of the cassettes are:

Weight	0.54 kg (1.2 lb) each
Size	2.54 cm × 16.5 cm dia. (1" × 6.5" dia.)
Volume	0.54 dm^3 (0.02 ft^3)

For the weight and volume of the cassettes included in the COLs, see the definition sheets on "Film, Cine".

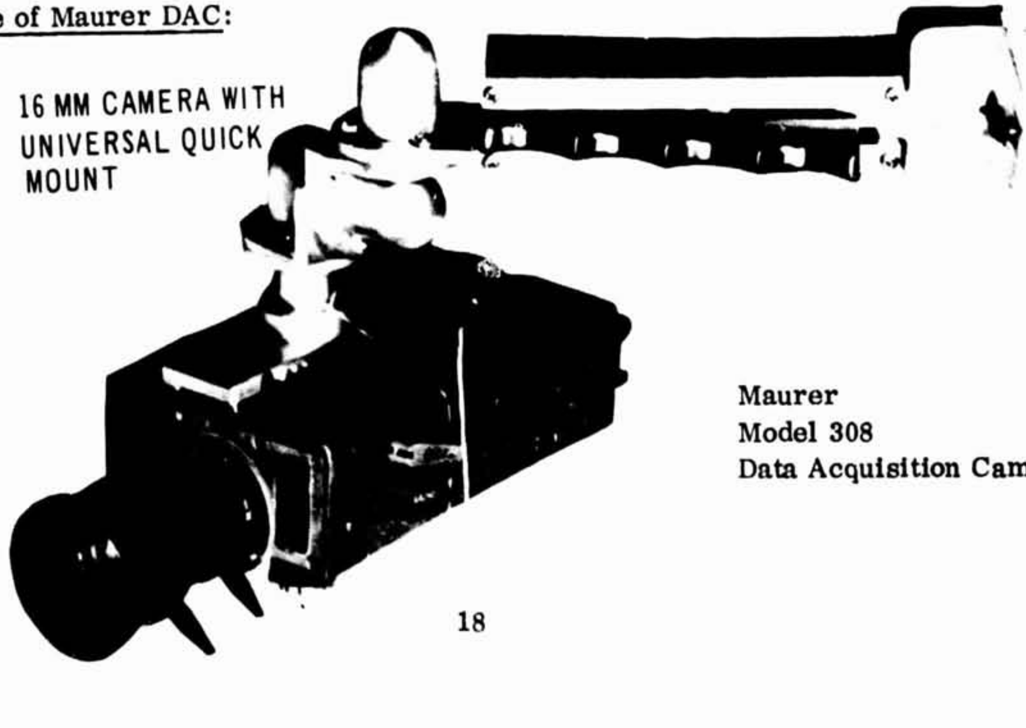
Cost

The Maurer camera and accessories could probably be government furnished. The Beaulieu camera mentioned above as a possible camera for use sells for \$2500-\$3500. Preliminary estimates for a flight type camera are:

Development	\$10K
Unit	\$6K

Development Time: tbd.

Picture of Maurer DAC:



Maurer
Model 308
Data Acquisition Camera

Basic principle of BEAULIEU electronic regulation

Should the motor's speed drop, the e.m.f. delivered by a dynamo coupled to the motor also drops; at this instant a transistorized amplifier delivers a higher current to the motor thus enabling it to resume its selected speed.

Naturally, this feedback system acts in the opposite way should the motor's speed increase. This regulation control occurs within a few thousandths of a second—and acts continuously, thus ensuring completely even film transport.

E.I. C37 CAMERA, VIDEO, BLACK/WHITE

Purpose

To monitor experiment events and phenomena.

Requirements

Estimated requirements are:

Visual Response	Approximate human eye
Video Output	Constant with light level changes of 10-10,000 ft-candles
	1.4 V. P-P composite, conforms to EIA RS-170 standard

Hardware Status

Model ED 6038A TV Instrumentation Camera, by General Electrodynamics Corp. appears adequate for the carry-on laboratories (COLs). This unit is space vehicle qualified and operates from 28 VDC. It is described in the attached catalog sheets.

Technical Description

Camera:	Weight	0.54 kg (1.2 lb)
	Size	3.8 cm Dia. × 15.2 cm L. (1.5" Dia., 6" L.)
	Volume	172 cc (.006 ft^3)
Control Unit:	Weight	3.86 kg (8.5 lb)
	Size	12.2 cm H. × 16.5 cm W. × 14 cm D. (4.8" H., 6.5" W., 5.5" D.)
	Volume	2.82 dm^3 (0.1 ft^3)
	Power	15 w, 28 VDC

Cost

Estimated costs are:	Development	$1K
	Unit	$13K
	Commercial	$10K

Development Time: Negl.

MINIATURE

Three actual size photographs on succeeding pages tell how small the camera really is. What they cannot tell is that the ED 6038 A camera head weighs only 14 ounces and the ED 6038 A-1 camera head weight is 48 ounces. The control unit has a depth of 6½ inches and weighs 8¼ pounds.

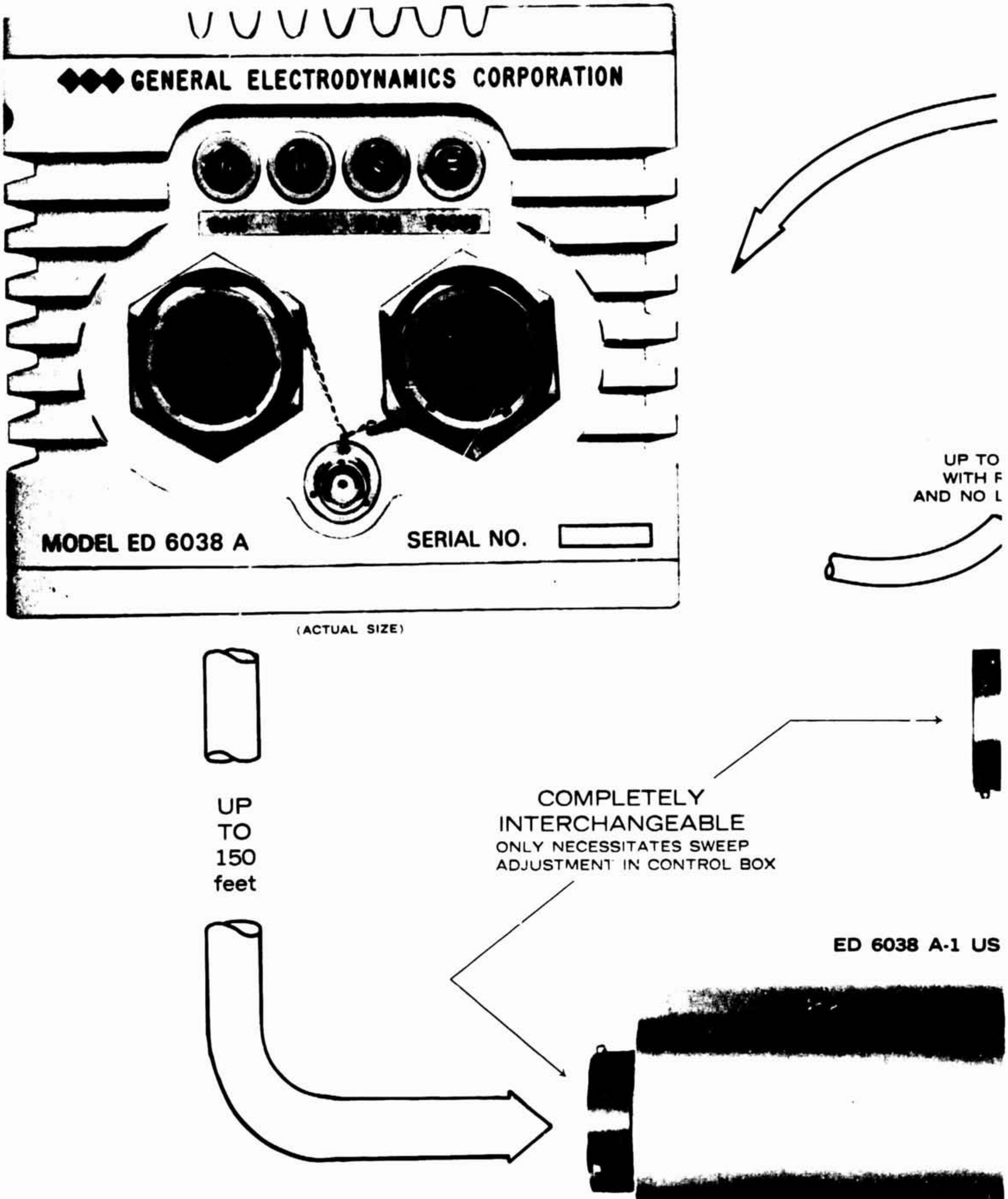
RUGGED

Look at the environment in which this camera will operate:

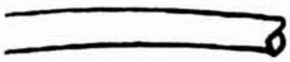
Vibration	20 cps — 2 kc random distribution 20 G's RMS in each of three axes 60 G's RMS for three seconds, in each of three axes
Shock	100 G's for 11 ms
Temperature	–10°C to +71°C, Operating
Relative Humidity	100%
Explosive atmosphere	
Ambient acoustical noise	More than 175 db overall sound pressure level
Altitude	Space Environment

VERSATILE

General Electrodynamics Corporation's total electro-optical capability enables it to quickly engineer most application requirements where instrumentation television is indicated. Our Electronic Tube Division supplies the "eye" for this camera. All you have to tell us is what the "eye" must see.


GENERAL ELECTRODYNAMICS CORPORATION
MODEL ED 6038 A
SERIAL NO.
UP TO
WITH F
AND NO L
UP
TO
150
feet
COMPLETELY
INTERCHANGEABLE
ONLY NECESSITATES SWEEP
ADJUSTMENT IN CONTROL BOX
ED 6038 A-1 US

(ACTUAL SIZE)



24 to 36 V.D.C.
15 watts

COMPOSITE VIDEO SIGNAL
CONFORMS TO EIA
STANDARD RS-170

1500 feet
G 59
INE AMPLIFIERS

7

ED 6038 A USES ½-INCH TD 1305 VIDICON 500 TV LINES RESOLUTION

"D"
MOUNT
LENS

(ACTUAL SIZE)

ES 1-INCH TD1339 VIDICON 700 TV LINES RESOLUTION

"C"
MOUNT
LENS

(ACTUAL SIZE)

E.I. 37 CAMERA, VIDEO, BLACK/WHITE (CONT.)

FEATURES

Electrostatic Focus Vidicon Tube
Sampling of yoke currents assures vidicon protection from sweep failure
Plug-in printed circuits
Solid state system
Reliable, detailed pictures under adverse environmental conditions.

ACCESSORIES

LENSES

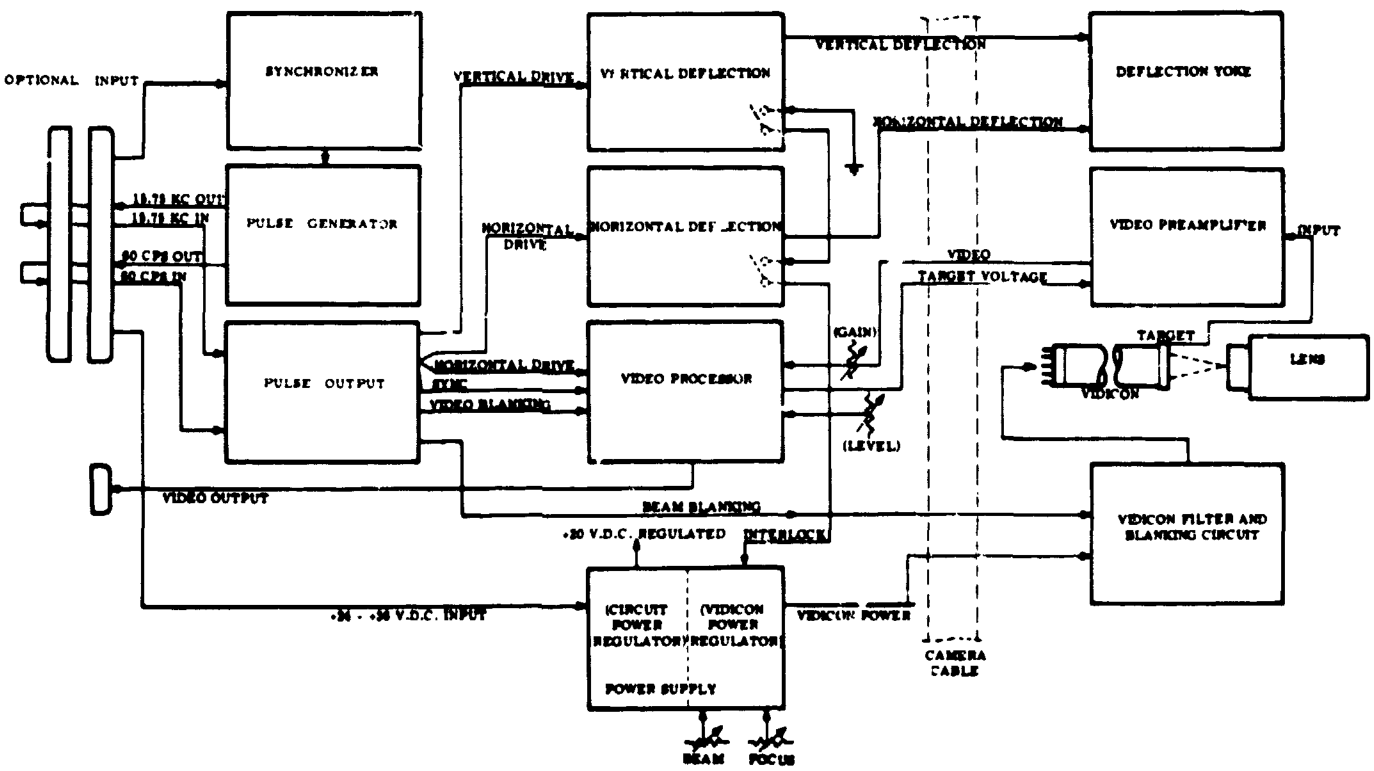
5.5 mm	f/1.8	(GEC 1499)
10 mm	f/1.8	(GEC 2035)
25 mm	f/1.4	(GEC 2036)
38 mm	f/2.8	(GEC 2037)
75 mm	f/4.2	(GEC 2038)

HEAD MOUNT MODEL MD 380

SPECIFICATIONS

Horizontal Scanning Frequency	15,750 cps
Vertical Scanning Frequency	60 cps
Interlace	2:1 30 fr/sec
Aspect Ratio, Height to Width	3:4
Sweep Linearity	Better than ± 1%
Sync and Blanking	Standard Broadcast EIA
Video Output	1.4 V PP composite into 75-ohm load
Automatic Constant Video Output	10 – 10,000 ft. candle
Usable Pictures	obtained with 1 ft. candle
Color Response	Approximates human eye
Grey Scale Reproduction	10 steps
Keyed Clamp	Provides constant black level
Voltage Regulation holds picture stable over 24 to 36 VDC	
Input Power	24 to 36 VDC, 15 watts

BLOCK DIAGRAM



ELECTRONICS DIVISION
GENERAL ELECTRODYNAMICS CORPORATION, GARLAND, TEXAS 75040
P. O. BOX 788 A/C 214 276 1161

E.I. C38 CAMERA, VIDEO, COLOR

Purpose

This camera is primarily used for visual color documentation which must be transmitted to ground during the progress of the experiments. It is expected that such transmission to ground will not be required for all experiments. Thus, the color video camera is a potential candidate for elimination from the carry-on laboratory (COL) complement of general purpose equipment, and might be considered as experiment specific instead. Visual color documentation which does not have to be transmitted to ground can be obtained with the still or motion picture cameras.

Requirements

Detailed requirements have yet to be determined. Some of the most stringent requirements anticipated have to do with the reproduction of specimens under microscopic examination. Documentation of MSI activities are required but should not pose any special problems.

Hardware Status

Color video cameras have been used aboard many of the past space flights. However, these cameras may not have adequate resolution for microscopy work. An advanced space flight camera has been developed by Lockheed for NASA (Telecommunication Development Division (TCDD)), and was used as the basis for the data presented below.

Technical Description

The Lockheed advanced spaceflight camera and camera controller have the following characteristics:

Camera

1.27 cm (1/2 inch) vidicon, 50 ft candle lower limit for good color
Resolution: 400 lines or better
8 to 1 zoom
Automatic Iris
12.7 cm high × 7.6 cm wide × 22.9 cm long (5 × 3 × 9 inches)
Envelope Volume: 2.21 dm^3 (0.078 ft^3)
Power: 19 watts DC
Weight: 2.7 kg (6 lb)

Camera Controller

The camera controller for the Lockheed spaceflight camera was assumed to have the following properties:

Weight	5 kg (11 lb)
Volume	4 dm^3 (0.14 ft^3)
Power	50 watts (exclusive of power which was included above)

Cost

Estimated cost for the camera and controller are:

Development	$300K
Unit	$100K

Development Time: tbd

E.I. C34 CAMERA, 35 MM

Purpose

To document visual experiment events and phenomena including microscopic images.

Requirements

Requirements have not been defined but probably would be satisfied by a high quality commercial camera.

Hardware Status

Existing commercial cameras are probably suitable. A Nikon camera with a F/1.2 lens was included in the Skylab equipment and was used here as a basis for the properties listed below.

Technical Description

Estimated properties of the 35 mm camera with film and accessories such as flash attachment and lenses are:

Weight: 2.0 Kg (4.4 lb)
Envelope Volume: 2.0 (0.07 ft^3)
Power: 0

Cost

Estimated costs are:

Development:	0
Unit :	$1K
Commercial :	$1K

Development Time

None

E.I. C190 CAMERA MOUNTS

Purpose

To provide structural support for the placement of the video and 35 mm cameras.

Requirements

The camera mounts should be portable so that they can be used in several predetermined locations within the Space Lab. In addition, the mounts should provide an adjustable head for proper aiming and positioning of the camera during operation.

Hardware Status

Modified versions of various commerical mounts will meet all the requirements for the Space Lab.

Technical Description

Estimated values are:

Weight	- 3 Kg (6.6 lbs)
Volume	- 3 dm^3 (.1 ft^3)
Power	- 0

Cost

Estimated costs are:

Development:	\$6K
Unit :	\$0.5K

Development Time

One year

E.I. C191 CAMERA TIMER, VIDEO

Purpose

To provide on-off control for the operation of a video camera used to monitor MSI performance experiments as well as other crews involved in Space Lab. activities.

Requirements

Required is a prescheduled time controlled switching device to control the video camera and the video tape recorder. This will be used for documentation of specific MSI experiments or general crew activity.

Hardware Status

A Sony Corporation video camera selector VCS-31 which provides camera on-off and switching capability could be modified to provide the desired controller. This modification would require the incorporation of a timing device that could be set manually to provide continuous or intermittent operation of the camera/recorder unit.

Technical Description

The estimated flight characteristics are:

Weight - 4 Kg (8.8 lbs)

Size 25 X 8 X 15CM (10 X 3 X 6 inches)

Volume - 3dm^3 (0.11 ft^3)

Power - 10 watts.

Cost

Estimated costs are:

Development:	$10K
Unit :	$0.3K

Development Time

One year

E.I. C50 CLINOSTAT

Purpose

To slowly rotate plant organisms relative to the laboratory. This device is used in ground based laboratories to neutralize the effects of gravity through slow rotation of the organism. It is included in the spacecraft equipment complement for the purpose of investigating its effectiveness in simulating zero-g and any artifacts that it may introduce relative to a true zero-g environment.

Requirements

Specific requirements are experiment specific. A small unit rotating in a single plane was assumed to be satisfactory for the carry-on laboratories (COLs). Rotation rates generally are between 0.1 to 2 rpm.

Hardware Status

A variety of custom designed and built units are currently in use throughout various laboratories. No commercial source of these devices is known, but the design and construction of one for space use is not expected to present any problems.

Technical Description

The clinostat design used as a basis for this study is essentially a small rotating drum upon which the plants are mounted so that they grow radially outward from the drum. The following properties were estimated for the COLs.

Drum diameter: 15 cm (5.9")
Total diametral clearance required for the drum and plants: 35 dm (13.8")
Drum length: 20 cm (7.9")
Total unit (cylindrical) envelope volume required while in operation: 20 dm^3 (0.71 ft^3)
Unit weight (excluding plants and media): 3 kg (6.6 lb)
Power: 10 watts

Cost

Estimated costs are:

Development	$3K
Unit	$0.7K

Development Time: < 1 yr.

E.I. C54 COLONY COUNTER

Purpose

For use in the manual counting of bacterial colonies.

Requirements

Standard colony magnifier/counter.

Hardware Status

Commercial units are available which should be applicable to space use with minor modifications to accept spacecraft power supply in lieu of 115 volt 60 Hz in the commercial unit.

Reference (a) Quebec Colony Counter, Darkfield Illumination APHA, Americal Optical No. 3330.

Technical Description

A typical commercial unit consists of a 10"×11"×10" box with 50 watt bulb inside, which illuminates a plate which is viewed through a magnifying glass, see attached figure. The properties of a flight type unit are estimated below.

Weight	1.5 kg (3.3 lb)
Power	50 watts
Volume	1.5 dm^3 (0.05 ft^3)

Cost

Estimated flight unit costs are:

Development	$2K
Unit	$0.5K

Commercial units cost approx. $0.2K.

Development Time: < 1 yr.

E.1. C54 COLONY COUNTER (CONT.)

C8375 C8376-1

C8375

COLONY COUNTER, Darkfield, Quebec (AO 3330) - For use in counting bacteria; colonies are presented against a dark background. Illumination provided by 40 or 50 watt tungsten bulbs; 4½" lens offers 1.5X magnification and is positioned to eliminate parallax errors. Lens is focusable by sliding rod or may be swung away when not used; a second lens may be attached for greater magnification. Unit is complete with Wolfhuegel guide plate; accommodates Stewart and Jeffers plates as well. Sheet metal case is finished in crinkled maroon enamel. Dimensions: 10"h × 11"w × 10"l. For operation on 115V, 60 Hz.

Order **C8375 - Counter** .... Each **$161.00**

5, ea **144.90**

EI C99   COMMON HOLDING UNIT

Purpose

To house a variety of biological organisms including cells and tissues, invertebrates, plants, and small vertebrates. These holding units provide structural support, environmental control system connections, hermetic isolation, and data management connections for these organisms and the related research.

Requirements

The common holding unit is intended as a basic housing to support a variety of organisms. However, slight modifications are required for the various organisms and experiments. The common holding unit must accommodate 8 small vertebrate cages (E.I. C30A) and other internal equipment peculiar to plant, invertebrate and cell/tissues research. It should be sealable in order to minimize air leakage into or out of the organism compartment, and should also be capable of withstanding a pressure differential of approximately 3.5 kN/m^2 (0.5 psi) in either direction. It must also be designed to mate with the debris containment shroud (E.I. C206). The common holding unit must incorporate a system for controlling its internal temperature. The temperature range required is estimated to be approximately 283 to 313°K (10 to 40°C or 50 to 104°F) for various organisms.

Hardware Status

Several prototype holding units have been built by General Dynamics Convair Aerospace for ground testing (see attached sheets). These are similar to those which would be required for the carry-on laboratories. However, a flight qualified unit has yet to be designed and built.

Technical Description

The common holding unit is the basic structure to be used for housing various experiment organisms. The unit is a sealable cabinet with doors for access to the organisms. It is intended to incorporate a system for temperature control of the atmosphere inside the holding unit. The Convair Aerospace unit uses liquid coils integral with the walls of the common holding unit for this purpose. Thus, in flight, the heat transport fluid of the spacecraft could be used to provide either heating or cooling to the common holding unit. The following are estimates for the common holding unit:

Weight:	20.4 kg (45 lb)
Volume:	188 dm^3 (6.64 ft^3)
Power:	50 watts (lights)

E.I. C99 COMMON HOLDING UNIT (CONT.)

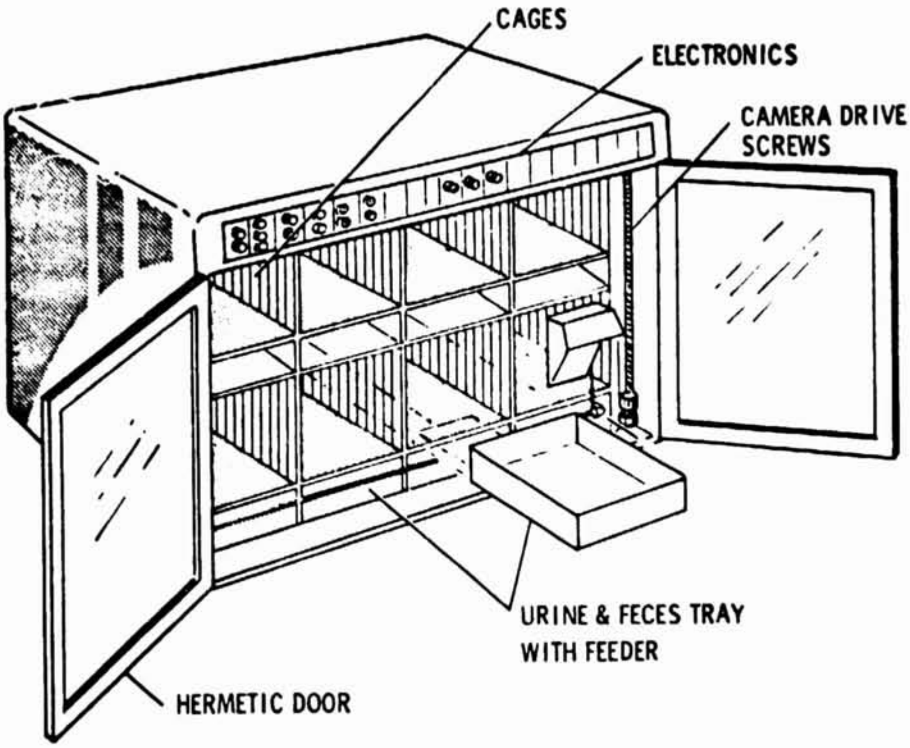
Cost

Costs for the common holding unit were estimated on the basis of designing and developing this basic unit so that it could be adapted for use with a variety of organisms. The resulting development program would need to consider the application of the basic structure to each individual F.P.E. and account for unique attachments, penetrations, and auxiliary equipment for each. Estimated costs are:

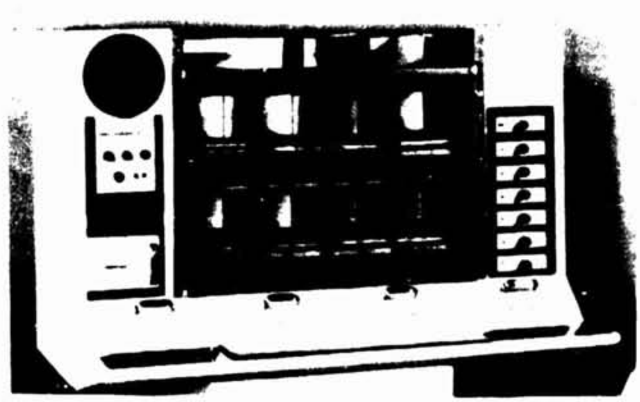
Development:	$1544K
Unit:	$ 55K

Development Time - 3 years.

E.I. C99 COMMON HOLDING UNIT (CONT.)



Common Holding Unit Concept with Cages for Small Vertebrates



Picture of Holding Unit Prototype Built by General Dynamics/Convair
Installed in COL Mockup

E.I. C156 COUPLERS

Purpose

To provide the necessary electrical signal transformation between various transducers and sensors, and the displays or recorders accepting the data output from these devices.

Requirements

Coupler requirements will vary depending upon the type of sensor, transducer, or control device being used. Couplers may be required to supply regulated voltages to some sensors such as those using voltage dividers or isolation amplifiers. Typical sensors are listed below:

a. ECG
b. EEG
c. EMG
d. Vectorcardiogram
e. Blood flow (Doppler)
f. Temperature Sensors
g. Photocells or Photoresistors
h. Pressure Transducers
i. Strain Gages (physiological measurements)

Hardware Status

Equipment similar to that used in the Statham Mueller patient monitoring system is typical of unminiaturized couplers. Some of this commercially available equipment is described in the attached catalog sheets. Couplers and signal conditioners are also discussed in the equipment definition sheet on sensors, E.I. C153B. Skylab contained couplers for electrophysiological measurements, some of which may be directly usable for the carry-on laboratory applications.

Technical Description

	Mueller Units	Preliminary Estimates, Flight Units	
Size	17.8 cm H × 5.1 cm W × 25.4 cm D (7" × 2" × 10×)	Volume	0.5 dm^3 (0.14 ft^3)
Volume	2.31 dm^3 (0.082 ft^3)	Power	2 watts
Power	About 10 watts	Weight	0.2 kg (0.44 lb)
Weight	0.5 to 2 kg (1.1 to 4.4 lb)		

E.I. C156 COUPLERS (Cont'd)

The total weight, power, and volume of the couplers for each COL will vary depending upon the experiments being conducted. For conceptual design purposes, 12 couplers of various types were assumed for most COLs. Thus, the total properties used were:

Weight	2.4 kg (5.3 lb)
Power	24 watts
Volume	6 dm^3 (0.2 ft^3)

<u>Cost</u>

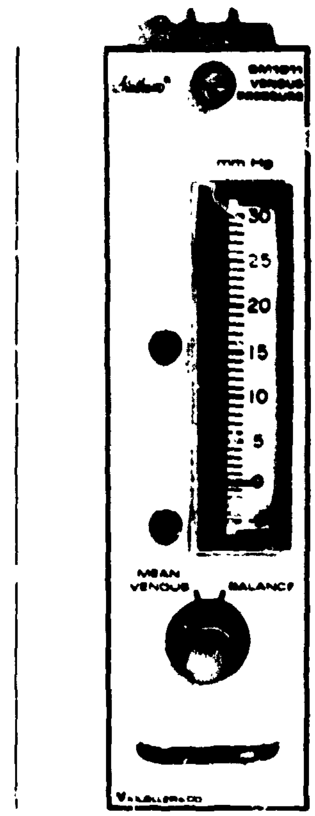
The development costs will depend upon the extent to which the Skylab type couplers can be used. Taking this into account, the following costs were estimated:

Development	$30K
Unit	$1.2 K each ($14K for 12)

<u>Development Time</u>: 1 year.

STATHAM MUELLER
MODULAR
PATIENT
MONITORING
SYSTEM

Venous Pressure Module, Model SM1011



The SM1011 Venous Pressure Module accepts venous pressure analog from either the SM1007 Blood Pressure Amplifier, or the SM1008 Bridge Amplifier, and from the input data computes and displays mean venous pressure.

A display meter on the front panel of the module indicates mean pressure over a range of −5 to +30 mm Hg. Two adjustable pointers on the face of the meter permit the physician to select acceptable minimum-maximum pressure limits. Should mean venous pressure exceed either of these limits, an alarm signal is generated by the SM1011 Module, triggering an audio/visual alarm at the central monitoring station. Minimum-pressure alarm function is feasible because the SM1011 removes the respiration component, largely responsible for negative venous blood pressure readings.

The Venous Pressure Module, Model SM1011, provides a standardized signal for display, strip-chart recording, magnetic tape recording, and/or computer analysis of the pressure reading.

Specifications

Dimensions	Standard SM Series 2-in Module
Meter scale	−5 - +30 mm Hg
Non-linearity	±1.0% FS from best straight line at constant line voltage and ambient temperature
Stability	±2.0% FS over temperature range of 50 - 140°F, and line voltage variations of 95 - 130V input to SM1014 or SM1034 Power Supply Modules
Output ripple	Negligible at full scale, 1.0% peak-to-peak at 10 breaths/min, and 50% modulation
Input impedance	100 kΩ minimum
Front-panel controls	Two-position selector switch/Mean venous/Balance NOTE: When set on "BAL," the selector switch also provides a balance indicator for the SM1007 or SM1008 Module, for purposes of setting atmospheric reference pressure.

We strive constantly for product perfection, both in design and construction. As a consequence, detailed specifications are subject to change without notice.

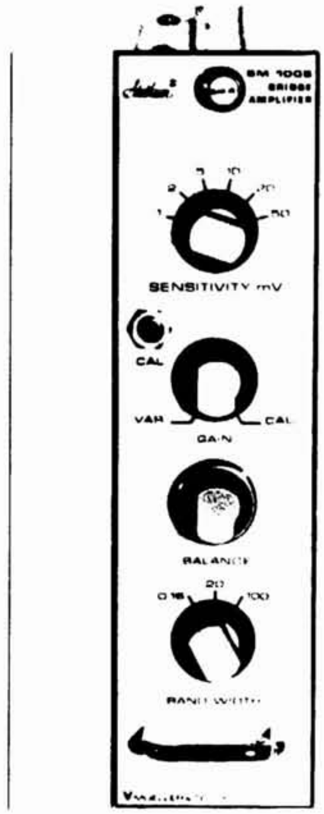
Features

- Minimum-maximum pressure limits adjustable on meter face
- Alarm signal generated when either pressure limit is exceeded
- Standardized signal for display, strip-chart or magnetic tape recording, computer analysis
- Fits any free position in an SM Series Cabinet

Bridge Amplifier Module, Model SM1008

The SM1008 Bridge Amplifier module provides excitation voltage for strain gage devices such as blood pressure transducers, and amplifies the signals received from them, conditioning the signals for oscilloscope display, strip-chart recording, magnetic tape recording, and/or computerization. It has 6 sensitivity ranges: 0 to 1 millivolt, 0 to 2 millivolt, 0 to 5 millivolt, 0 to 10 millivolt, 0 to 20 millivolt, and 0 to 50 millivolt, all selected by a 6-position switch; and a fine adjustment set by a vernier control that allows continuous gain over the range from 1 to 125 millivolt. Frequency response is selected by a 3-position bandwidth switch: dc to 0.16 Hz, dc to 20 Hz, and dc to 100 Hz.

Amplifier SM1008 is used with non-standardized 4-leg Wheatstone bridge transducers for a variety of physiological measurements. Among the transducers with which it is used are Statham's blood pressure transducers P23AA, P23BB, P23De, P23Gb, P23H, SF1, and SF4. It is also used with Statham's universal transducing cells UC2, UC3, and UC4, which, with appropriate accessories, are suitable for such measurements as force, displacement, weight, TKD, apex cardiograph, muscle strength, and blood pressure.



In common with the other elements of the system, an outstanding level of performance is achieved without demanding the operator's constant attention, thus allowing concentration on the information that is being made available. The controls on the front panel are: a selector switch for frequency, selector switch for sensitivity, vernier gain control, a knob to adjust the balance and a calibrator pushbutton.

In keeping with the system's design, output is standardized. This offers several significant advantages to the user: greater flexibility; insurance against obsolescence; compatibility with computers and recorders; ease of installation and service; and initial cost is kept down.

Specifications

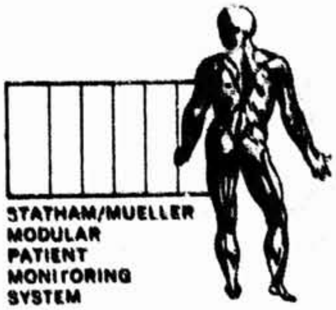
Signal input:	
Source	4-leg Wheatstone bridge transducers
Excitation voltage	7.5 V dc, ±5%
Transducer resistance	200 to 800Ω
Sensitivity: 6 calibrated positions	0 to 1 mV full scale 0 to 2 mV full scale 0 to 5 mV full scale 0 to 10 mV full scale 0 to 20 mV full scale 0 to 50 mV full scale with 7.500 V excitation
Vernier	Allows continuous gain from 1 to 125 mV full scale
Sensitivity stability	+1.5% of full scale, over specified environment
Sensitivity accuracy, including excitation and gain	±2% of full scale, 1 and 2 mV ranges ±1% of full scale, all other ranges
Frequency response:	dc to 0.16 Hz, −3 dB at 0.16 Hz dc to 20 Hz, −3 db at 20 Hz dc to 100 Hz, −3 dB at 100 Hz
Common mode rejection, 5 Vpp at 60 Hz	Better than −80 dB
Non-linearity	±1% of full scale
Zero drift, excluding transducer	±2% of full scale, from 65 to 85°F
Noise	1% of full scale, peak to peak, referred to input
Balance control	Ten-turn potentiometer with locking device
Calibration	100 kΩ ±1%, connected in parallel with legs 1 and 2 of Wheatstone bridge by means of pushbutton
Ambient temperature	60 to 100°F
Power	Derived from SM1014 Power Supply
Front-panel width	2" nominal
Weight	Approximately 3 pounds 9 ounces
Mounting	Position 1—7 in SM1015 Cabinet

Features

- For blood pressure transducers and other strain gage devices
- For use with non-standardized transducers
- Sensitivity range 1 to 125 millivolts
- 3 frequency response settings
- Outstanding performance without constant attention
- Standardized-level output
- All solid-state circuitry
- Triple isolation for safety

We strive constantly to improve the quality of all our products, both in their design and in their construction. Accordingly, detailed specifications are subject to change without prior notice.

Electronic Thermometer Module, Model SM1006



The SM1006 Electronic Thermometer Module accepts signals only from Statham's patient temperature probes (Rectal/Esophageal Probe SM3605 and Skin Temperature Probe SM 3604) and conditions them to provide continuous meter readout in degrees Fahrenheit and degrees Celsius. It gives warning when a pre-selected maximum or minimum limit is exceeded. It also provides a signal for audio/visual alarm at the central monitor station and a standardized signal for display, strip-chart recording, magnetic tape recording, and/or computerization.

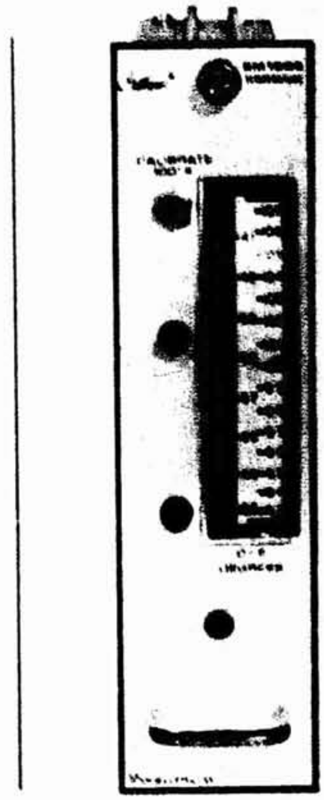
Temperature within the pre-selected limits is indicated by a green light. A red light indicates that either the maximum or the minimum has been exceeded. The limits are set by two pointers on the large, easy-to-read meter. They may be reset at any time, within the meter range of 93 to 107° F, or 34 to 41° C.

Statham's Rectal/Esophageal Temperature Probe, SM3605, and Skin Temperature Probe, SM3604, are standardized to ±0.2° F; no further standardization is needed to use either of the probes with the SM1006 Electronic Thermometer. A pushbutton on the front panel provides a calibration check at the 100° F point and an indication of the meter at 100° F (half-scale point). A screwdriver adjustment on the front panel is used to correct the calibration, if needed.

In common with the other elements of the system, an outstanding level of performance is achieved without demanding the operator's constant attention, thus allowing concentration on the information that is being made available. The only control on the front panel is the pushbutton to check calibration.

In keeping with the design of the system, output is standardized. This offers several significant advantages to the user: greater flexibility – insurance against obsolescence – compatibility with computers and recorders – ease of installation and servicing – initial cost can be kept down.

As is true for all elements of the system, all solid-state circuitry is employed, and is rated conservatively throughout. Careful attention is paid to every design detail; full advantage is taken of modern electronic and semiconductor technology. Thus, with Statham's tradition of using the finest materials, the most careful manufacturing, and the most rigid quality control, high reliability and long trouble-free life are assured, with resultant long-range economy.



Specifications

Meter Scales	93 to 107°F 34 to 41°C
Non-Linearity	±1% of full scale
Accuracy	±0.4°F, using Statham Probes SM3604 or SM3605
Calibration	At 100°F by front-panel pushbutton
Calibration Adjustment	Single-turn potentiometer, screwdriver adjustable
Ambient Temperature	60 to 100°F
Power	Derived from SM1014 Power Supply
Front-panel Width	2", nominal
Weight	Approximately 3½ lbs.

We strive constantly to improve the quality of all our products, both in their design and in their construction. Accordingly, detailed specifications are subject to change without prior notice.

Features

- Rectal, esophageal, or skin temperature
- Continuous meter readout in °F and °C
- Maximum/minimum alarm
- Standardized probes
- Pushbutton calibration check
- Outstanding performance without constant attention
- Standardized-level output
- All solid-state circuitry

F.7 C55A CREW MOBILITY AIDS

Purpose

To aid in the mobility of the astronauts while they are attending to experiments being conducted with the carry-on laboratories.

Requirements

These aids are intended to be general in nature. Aids for specific crew motions associated with particular experiments such as pressure suit tests are not intended to be included. These would be experiment specific items. Also, mobility aids built into the spacecraft floor or other structure are not considered to be a part of the carry-on laboratory (COL). The mobility aids should be compatible with crew motions consistent with experimentation procedures. Such motion will generally be at a moderate pace and a short range around the carry-on lab. Small objects such as hand tools or liquid samples may be conveyed during these movements.

Hardware Status

The following aids may be applicable to the COLs.

a. Handrails. Rails with a rectangular or oval cross-section set off from the surface at least two inches. Parallel rails provide better control than the single handrail, although both are adequate. Development status - fully developed and flight qualified on Gemini and Apollo.

b. Handholds. One-half to $1\frac{1}{2}$ inches in diameter and $4\frac{1}{2}$ inches inside width with a 2-inch clearance from surrounding surfaces. Can be either recessed or protruding. Recessed type is a better mobility aid, as it presents minimum potential for interference of movement. Development status - fully developed and flight qualified on Gemini and Apollo.

c. Leg Holds. Protrusions which would allow short range crew motions around the COL by means of leg motions. Development status - conceptual design item.

E.I. C55A CREW MOBILITY AIDS (Cont'd)

Technical Description

	Handrails	Handholds	Leg Holds
Weight	1.27 kg/m (0.85 lb/ft)	390 g (.85 lb)	450 g (1 lb) est
Volume	0.046 $\frac{dm^3}{dm}$ (.005 ft^3/ft)	0.142 dm^3 (.005 ft^3)	0.57 dm^3 (.02 ft^3)
Power	0	0	0

Total weight and volume estimates for the COLs are:

Weight	2.3 kg (5 lb)
Volume	2.8 dm^3 (.1 ft^3)

Cost

Development	$2K
Unit	$1K

Comments

See Ref: Mobility and Restraint Handbook, Contract NAS9-10456, August 1970.

E.I. C55B CREW RESTRAINTS

Purpose

To restrain the crewman while attending to carry-on laboratory (COL) experiments.

Requirements

Crew restraints should allow effective experimental operations with a minimum of crew time and energy diverted to the restraint task. These restraints will generally be used in conjunction with the various test benches or consoles. For example, LSPS activities will generally include routine data collection, adjustments (valve turning, switch operation, etc.), sample taking, weighting procedures, etc. Nothing of a vigorous nature is expected. Restraints needed for particular experiments such as suit tests, commode tests, or shower tests are considered to be experiment specific. Restraints for certain biomedical and biology tasks must be compatible with precision operations such as microdissection.

Hardware Status

The following restraint concepts may be applicable to the carry-on laboratories:

a. Leg Rail: Development status - untested. Development time - less than six months.

b. Flexible Waist Tethers: Development status - untested, but related concept flight-qualified on Gemini.

c. Inflatable Mid-Torso: Development status - untested. Development time estimated to be six months to one year.

d. Handholds.

e. Handrails.

f. Rigid Waist Tether.

g. Seats.

h. Heel Restraint: Used aboard Skylab. General foot-type restraints are considered to be a part of the supporting spacecraft. The restraints listed above would have to be designed to work in conjunction with such foot or other restraints aboard the supporting spacecraft.

E.I. C55B CREW RESTRAINTS (Cont'd)

Technical Description

Restraint Concept	Wt. (kg)	Volume (dm^3)
Leg Rail	1.5 kg/m	19 dm^3/m
Flexible Waist Tether	0.91	5.7
Inflatable Mid-Torso	1.5	11
Handholds	0.39	0.14
Handrails	1.3 kg/m	0.47 dm^3/m
Rigit Waste Tethers	3.4	23
Seats	2.0	10
Heel Restraints	0.17	~1

Total estimated weight and volume of restraints for the COLs were 4.0 kg (8.8 lb) and 10 dm^3 (0.35 ft^3).

Cost

Development	$3K
Unit	$1.8K

Development Time: < 1 yr.

Comments

See Ref.: Mobility and Restraint Handbook, Contract NAS9-10456, August 1970.

E.1. C192 DISPLAY, NUMERIC

Purpose

To display data and other information to the COL operator. The signals displayed will emanate from the COL equipment sensors and outside sources such as the command and data management subsystem (CDMS).

Requirements

The display characteristics have yet to be determined. The major use will be the display of sensor outputs. Probably two 4-digit display would be adequate. Symbols should be readable from approximately one meter from the display. Also, selector switches would be required with the display in order to select the signal to be displayed.

Hardware Status

Commercially available equipment should be adaptable for use.

Technical Description

Estimated properties of a flight display, selector switches, and electrical interconnections are:

Weight	2 kg (4.4 lb)
Volume	4 dm^3 (0.14 ft^3)
Power	2 watts

Cost

Estimated flight item costs are:

Development	\$6.5K
Unit	\$1K (total)

Commercial costs of such units are approximately \$0.3K.

Development Time: < 1 yr.

E.I. C167B DRY STORAGE CONTAINER

Purpose

To provide a dry storage area for biological specimens, biochemicals, and other biological materials.

Requirements

Specific requirements have not been determined. In general, atmospheric conditions within the spacecraft cabin are expected to be satisfactory for this storage. However, the storage container should be sealed when material is not being transferred to or from the container.

Hardware Status

Spacecraft components for this storage container should be available.

Technical Description

The estimated size and weight of this container for the COLs are given below:

	7-Day Mission	30-Day Mission
Weight	0.5 kg (1.1 lb)	1 kg (2.2 lb)
Volume	3 dm^3 (0.11 ft^3)	6 dm^3 (0.21 ft^3)

Cost

Development	$5K
Unit	$0.2K

Development Time: < 1 yr.

E.I. C196 EQUIPMENT RESTRAINTS

Purpose

To hold small biomedical equipment that the crewman will be working with in the 0-g environment.

Requirements

This device would be used to hold down capillary tubes, vacutainer tubes, petri dishes, sensors and probes, swabs, wipes, pipettes, tools, etc. Several types of hold down may be necessary to accommodate all the various types of research equipment.

Hardware Status

Hold downs of various types have been used in past space flights. However, the unique life science laboratory test procedures and equipment may require special designs. One such design is shown in the attached sketch.

Technical Description

The following weight and volume were estimated for hold down devices for the carry on laboratories.

Weight	0.5 Kg (1.1 lb)
Volume	1 dm^3 (0.035 ft^3)

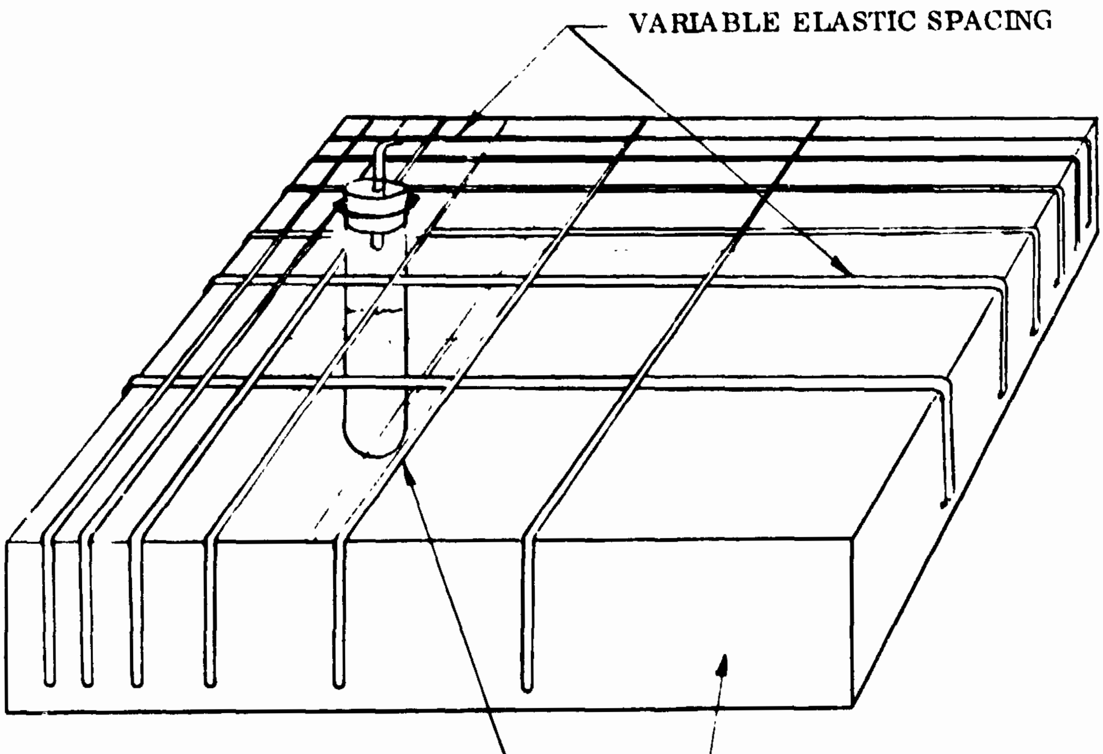
Cost

Estimated costs are:

Development:	$4.6K
Unit :	$0.2K

Development Time

One year



A POTENTIAL TYPE OF SMALL EQUIPMENT RESTRAINT DEVICE

E.I. C76C FILM, CINE

Purpose

This film is for use in the cine cameras for documentation of experiment events and phenomena.

Requirements

Requirements have yet to be determined. The amount of film required can vary substantially depending upon the specific experiments. The type of film may also depend upon the specific experiments.

Hardware Status

For purposes of carry-on laboratory conceptual design, the 16 mm cine film cassettes which were used on Skylab were assumed to be usable.

Technical Description

The individual 16 mm film cassettes have the following properties:

Weight	0.54 kg (1.2 lb)
Size	2.54 cm × 16.5 cm dia. (1" × 6.5 " dia.)
Volume	0.54 dm^3 (0.02 ft^3)
Film Length	122 m (400 ft) (~ 45 minutes of filming)

The quantity of film required for the COLs was estimated to be four 16 mm cassettes for 7 days and 12 cassettes for 30 days as follows:

	7-Days	30-Days
Weight	2.2 kg (4.9 lb)	6.5 kg (14.3 lb)
Volume	2.2 dm^3 (0.08 ft^3)	6.5 dm^3 (0.23 ft^3)

Cost

Development	0
Unit	~ \$0.2 K (total for 30 days)

Development Time: None

E.I. C167C FILM CABINET

Purpose

To store various types of photographic film before and after use.

Requirements

This storage area should be shielded from high energy particles in the space environment. The storage volume required was estimated to be 8 dm^3 (.28 ft^3) for both cine and still film cartridges.

Hardware Status

This storage cabinet will probably need to be custom configured for the COL but will use standard materials.

Technical Description

For conceptual design purposes, the following properties were used for a film storage cabinet including shielding:

Weight	9.1 kg (20 lb)
Size	Approx. 2.08 × 2.08 × 2.08 dm^3 (8.2"×8.2"×8.2")
Power	0

Cost

Estimated values are:

Design	$2K
Unit	$1K

Development Time

< 1 year.

E.I. C197 FLOWMETERS

Purpose

To measure gas and liquid flows to and from various test equipment.

Requirements

Specific requirements will depend upon the experiments being conducted. Flow measurements to and from the test equipment will most likely include spacecraft coolant (probably water), fresh water from storage, and gases from storage. Liquid flows are expected to be on the order of 0-100 kg/hr. Gas and liquid flows internal to individual test equipment are assumed to be part of this test equipment and not a part of the COL.

Hardware Status

Standard techniques can probably be utilized for flow measurements. Pressure drop devices such as laminar flow elements or orifices should be applicable in many cases. Hot wire anemometers may also be used for gas flow measurements. Differential pressure sensors for use with the pressure drop devices utilize either mechanical or solid state pressure sensing elements. Signals from these pressure transducers would probably be fed to the spacecraft data management subsystem for recording and display. Direct reading pressure gages are also available but may not be needed. A typical flow rate transducer is described in the attached specification sheets taken from:

> Environmental Control and Life Support '71 Component Specifications, Report No. 18-4-008, Basic Subsystems Module Definition Study, Contract NAS9-6796, General Dynamics/Convair, 17 October 1967.

Technical Description

The weight, power and volume of four pressure drop type flowmeters, including the pressure transducer and signal conditioner, are estimated below. Four such units were assumed to be necessary in the LSPS COLs.

Weight:	2 kg (4.4 lb)
Volume:	2 dm^3 (0.072 ft^3)
Power:	4 watts

Cost - Estimated costs for flight items are

Development:	\$39K
Unit:	\$0.8K each (\$3.2K for four)

Development Time: < 1 year.

FLOW-RATE TRANSDUCER
(APOLLO P/N 836112)

PURPOSE

The flow-rate transducer measures the rate-of-flow of the process gas.

DESCRIPTION

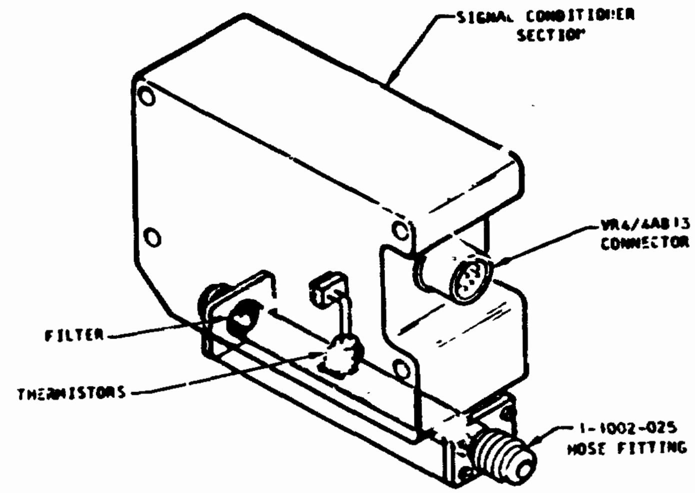
The transducer is powered by the 28 vdc supply of the spacecraft and operates over a flow range of 0.2 to 1.0 lb per hr. An electrical signal (0 to 5 vdc) proportional to the oxygen flow-rate is provided by the transducer. This signal is used for ground checkout, for the crew's visual information, via an indicator, and for telemetry data to be transmitted to a ground station. A static switch is actuated in the event of an overflow condition (at 1 lb per hr), which turns on an indicator light.

PERFORMANCE AND DESIGN DATA

Operating flow range, lb/hr	0.2 to 1.0
Max overflow, lb/min	0.7 (42 lb/hr)
Accuracy, lb/hr	±0.048 (±0.30 v) 0 to 150°F
Differential pressure	1.0 psi max at 1.0 lb/hr and 100 psig inlet 8.0 psi max at 0.7 lb/min and 100 psig inlet
Operating temp range, °F	-40 to +165 (ambient 0 to 150)
Time constant, sec	15 max (to 63.2% with applied step flow rate
Output signal	0 v at 0.2 lb/hr at 5.0 vdc at 1.0 lb/hr 6.5 vdc max at greater flows
Output ripple, mv rms	Ripple component of output signal shall not exceed 10
Output load, ohm	30,000
Fitting ends	MS 33656-4 (1/4 in. OD tube)
Line pressure, psig	85 to 140 (100 nominal)
Proof pressure, psig	210
Burst pressure, psig	350
External leakage	6 x 10^{-6} lb/hr O_2 max with 140 psig internal pressure at 70°F
Electrical power requirements	
Input voltage, vdc	28 per SS-1070
Excitation current, ma	80 (max)
Weight, lb	1.0

QUALIFICATION STATUS

The flow rate transducer is a qualified Block II Apollo component.



FLOW RATE TRANSDUCER

E.I. C80 FREEZER, GENERAL

Purpose

Storage of serum, plasma, specimens, biochemicals, and organisms.

Requirements

Estimated requirements are:

Temperature:	253°K (-20°C, -4°F)
Storage Volume:	6 dm^3 (0.21 ft^3)

Hardware Status

Freezers were used aboard Skylab but their design will probably not be suitable for the COLs. The Skylab freezers utilized a special low temperature space radiator containing Coolanol 15, a heat storage device, pumps, etc. The cold boxes were cooled to 244°K (-29°C, -20°F) by pumping the radiator fluid through tubing integral with the walls of the boxes. Such a system is too complex for the small freezer required for the COLs and also places a limitation on the orientation of the Shuttle Orbiter/SPACELAB.

For the small freezer required for biospecimens, a thermoelectric unit may be suitable for use. However, such a unit will have to be designed to minimize power consumption since thermoelectric refrigeration units are quite inefficient. Vapor compression units are much more efficient but their adaptation to the 0-g environment has not been recommended in past tradeoff studies because of the potential gas/liquid handling problems.

Technical Description

A thermoelectric freezer was assumed for purposes of defining conceptual COL designs. A design analysis for this freezer was conducted with the assistance of the following booklet published by Borg-Warner Corp:

> Beosen, G. F., Phetteplace, C. J., and Ybarrondo, L. J., The Where and the Why of Cooling Thermoelectrically, Borg-Warner Corp., Des Plaines, Illinois, 1967.

For a 6 dm^3 (0.21 ft^3) cold box, well insulated with 2.54 cm (1") of glass wool or foam type of insulation (k = .02 Btu/hr-ft-°F), the heat load into the box was estimated at 5 watts including heat leaks through the door flange, etc. The temperature difference was taken as 27°C (80°F) ambient minus -20°C cold box temperature or 47°C. At this temperature difference, Borg-Warner reports a C.O.P. of 0.3 for

their single stage thermoelectric module, model number 920 with vacuum insulation. Thus, the steady state input power would be 5 watts/.3 = 16.7 watts. Assuming a duty cycle of 8 hours on-time per day leads to a value of 50 watts while the freezer is on. The use of spacecraft coolant, as a means of reducing this power, was also analyzed. A possible reduction of up to 50 percent was estimated but was not considered worth the extra complexity associated with integrating the freezer into the spacecraft heat rejection subsystem. The calculations on the freezer are preliminary in nature and were used only to establish values for the COL conceptual designs. Actual freezer heat loads are difficult to calculate and would be the subject of empirical determinations or sophisticated computer program analyses in future design efforts.

The preliminary weight, volume and power of the general freezer are:

Weight: 7 kg (15 lb)
Power: 50 watts
Volume: 15 dm^3 (0.53 ft^3)
Coolant Flow Required: None

Cost

Estimated costs are:	Development:	$54K
	Unit:	$5K

Development Time: 1 year.

E.I. C81 FREEZER, LOW TEMPERATURE

Purpose

This unit provides storage for some specimens (in particular blood samples) which are partially destroyed at usual freezer storage temperatures of -20°C.

Requirements

Estimated requirements are:

Temperature:	203°K (-70°C)
Storage Volume:	Approx. 1 dm^3 (0.04 ft^3)

Hardware Status

No freezers with a -70°C temperature capability have been flown in spacecraft, and the development of such a freezer may present a number of problems. Thermoelectric freezers are commercially available but consume a large amount of electric power. A commercially available unit called an Electronic Cryo-Bath (available through the Cole Parmer Instrument Co.) contains an 80 cc cold chamber. Its power supply consumes 185 watts, providing a temperature of about 218°K (-55°C, -67°F). To increase the cold chamber volume to 1 dm^3 and reduce the temperature to 203°K (-70°C, -94°F) would require a substantial increase in power.

Lower power consuming vapor compression units are available for temperatures down to -70°C, but past studies on vapor compression units indicate that they would be difficult and costly to modify for operation in zero-g. Use of cryogenics might be the simplest way to obtain such low temperatures for short missions.

Technical Description

For purposes of COL conceptual design, a thermoelectric type of low temperature freezer was assumed. The power requirements were estimated based upon the data presented in the following reference:

> Boesen, G. F., Phetteplace, C. J., and Ybarrondo, L. J., The Where and the Why of Cooling Thermoelectrically, Borg-Warner Corp., Des Plaines, Illinois, 1967.

For the low temperature freezer, spacecraft coolant was assumed as a heat sink along with the following assumptions:

1. Coolant @ 280°K (7°C or 45°F).
2. Use of multiple 3-stage thermoelectric modules (Borg-Warner model #623 in the reference cited above).
3. High performance insulation.
4. Very limited opening of the freezer.
5. A duty cycle of 8 hours on-time per day.

Using these criteria, a power requirement of 400 watts was estimated. This value is a preliminary estimate only. It depends greatly upon the actual insulation quality which can be achieved in the freezer.

Complex analyses and/or empirical data would be required to accurately determine the power requirement.

The weight, volume and power estimates for the low temperature freezer are:

Weight: 7 kg (15 lb)
Power: 400 watts
Volume: 15 dm^3 (0.53 ft^3)
Coolant Required: 150 kg/hr (331 lb/hr or 37.9 gph) at 280°K (7°C or 45°F)

The low temperature freezer could possibly be placed within the general freezer (-20°C) in order to reduce the total insulating material requirements of these freezers.

Cost	Estimated costs are:	Development:	$81K
		Unit:	$6K

Development Time: 1 year.

E.I. C89 GAS CHROMATOGRAPH

Purpose

To measure the concentration of individual gases in gas mixtures.

Requirements

The requirements will depend upon the specific experiments. Common gases which will require monitoring include O_2, N_2, H_2, CO_2, CO, CH_4, H_2O, NH_3, and He. The concentrations of these gases will vary but will include levels in the parts per million range.

Hardware Status

Commercial units are available but would probably require modifications for flight use. Data on a Beckman unit designed and built for space applications is presented in the accompanying pages.

Beckman Instruments has built several gas chromatographs for spacecraft applications. A spaceborne gas chromatograph prototype was built in 1962 for possible use on Apollo and other advanced missions. Also, a gas chromatograph to be integrated with a mass spectrometer was recently built for the Viking (Mars lander) mission.

Technical Description

The Beckman spaceborne gas chromatograph (1962) had the following properties:

Weight	5.4 kg (12 lb)
Volume	Approximately 13 dm^3 (0.46 ft^3)
Power	6 watts
Number of gases monitored	10 (preselected)
Operating time	8 weeks

The unit built for Viking is an integrated soil pyrolyzer, gas chromatograph, and mass spectrometer (GCMS). The mass spectrometer was made by Perkin Elmer, see E.I. C91. The total integrated unit has the following properties:

E.I. C89 GAS CHROMATOGRAPH (Continued)

Weight	19.5 kg (43 lb)
Volume	28 dm^3 (1 ft^3)
Carrier Gas	Hydrogen

A gas chromatograph of the type used in the Viking GCMS but for use in the life sciences carry-on laboratories was estimated to require less than 50 watts during all phases of operation. At times, the power would be less than this since the heating of the GC columns varies during the cyclic operation of the unit. Each analysis would require about 20 minutes.

For comparison with the above data, a commercially available Beckman Model GC 2A has the following properties exclusive of the He carrier gas.

<u>GC 2A</u>

Weight	41 kg (90 lb)
Volume	79 dm^3 (2.8 ft)
Power	575 watts (maximum)
He carrier gas flow	approximately 2 cc/min

<u>H_2 Flame Detector</u>

Weight	12 kg (26 lb)
Volume	39 dm^3 (1.4 ft^3)
Power	Unknown

For conceptual design purposes, the following properties were used for a gas chromatograph for the carry-on laboratories:

Weight	10 kg (22 lb)
Volume	20 dm^3 (0.71 ft^3)
Power	50 watts

<u>Cost</u>

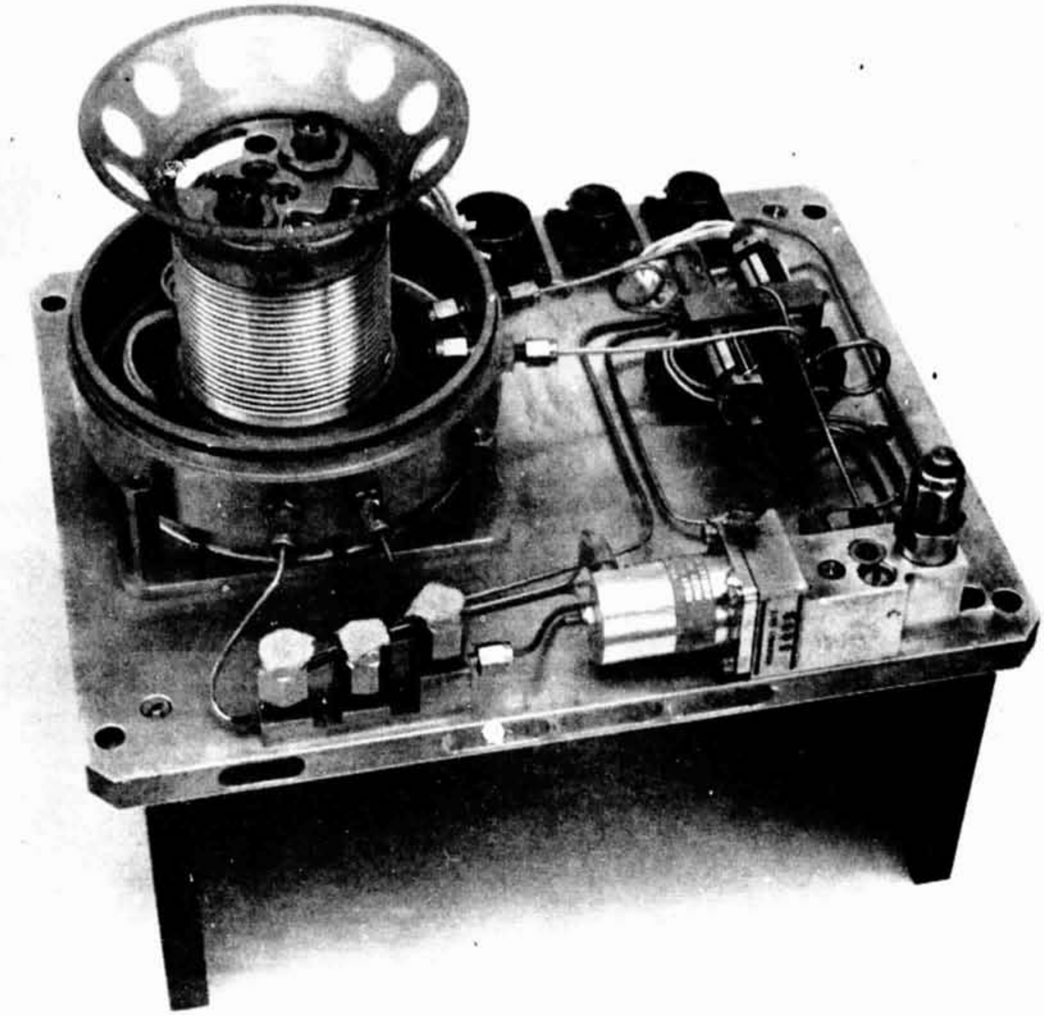
Estimated flight equipment costs are:

Development	$221K
Unit	$66K

E.I. C89 GAS CHROMATOGRAPH (Continued)

The cost of commercially available gas chromatographs are approximately $5K.

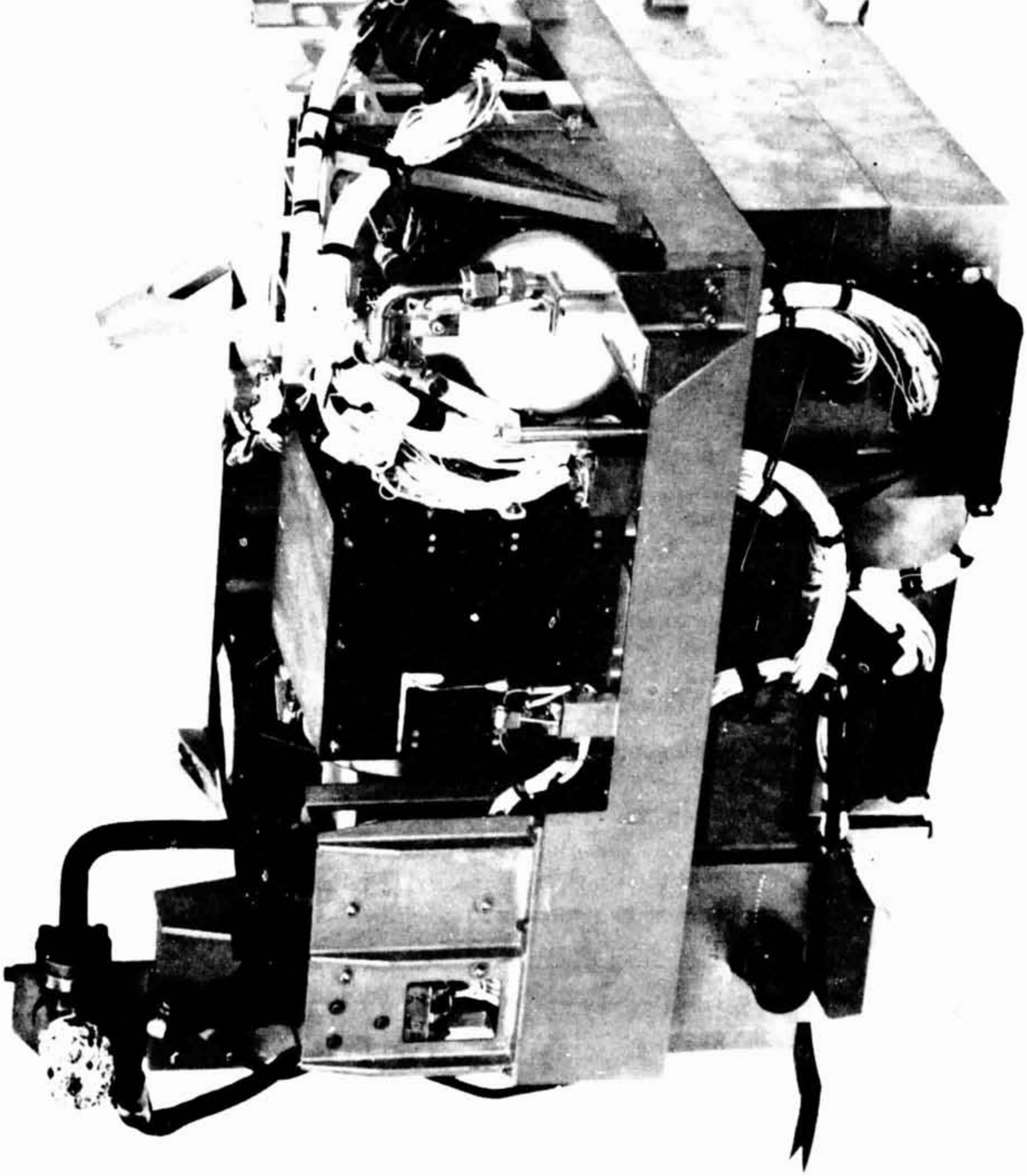
Development Time: 2 years.



BECKMAN SPACEBORNE GAS CHROMATOGRAPH

SERVO INDICATOR FOR SPACEBORNE GAS CHROMATOGRAPH

E.I. C89 GAS CHROMATOGRAPH (CONT.)



COMBINED GAS CHROMATOGRAPH & MASS SPECTROMETER FOR THE VIKING MISSION

E.I. C93A GAS SUPPLY VESSELS

Purpose

To provide gases to the various LSPS experiments.

Requirements

Various gases will be required in LSPS experiments for purposes of pressurization, chemical reactions, sterilization purging, cooling, etc. Some of the gases which may be needed include O_2, N_2, H_2, NH_3, He, Air, CO_2, CO, CH_4, ethylene oxide. The quantities required will depend upon the experiments. However, for preliminary design purposes, two, 13,800 kN/m^2 (2000 psia) vessels of approximately 15 dm^3 (.53 ft^3) capacity were assumed.

Hardware Status

High pressure gas vessels have been used in numerous past space flights. Thus, applicable designs or hardware should be available.

Technical Description

Each of the two vessels was assumed to hold 15 dm^3 (.53 ft^3) of gas. Such a vessel would hold 2.7 kg (6 lb) of O_2 or 2.4 kg (5.3 lb) of N_2. These gases were assumed for purposes of estimating weights. The vessel weights (empty) were estimated to be 3.2 kg (7.1 lb) each. The total envelope volume of each vessel was assumed to be 18 dm^3(0.64 ft^3) to account for lines, valves, and regulators. A summary of the estimated properties of these two vessels is given below:

	O_2	N_2
Weight empty kg (lb)	3.2 (7.1)	3.2 (7.1)
Gas, weight kg (lb)	2.7 (6)	2.4 (5.3)
Total weight kg(lb)	5.9 (13.1)	5.6 (12.4)
	11.5 (25.5)	
Volume dm^3 (ft^3)	18 (.64)	18 (.64)
	36 (1.28)	
Vessel length (ea)	4.7 dm (1.5 ft)	
Vessel diameter (spherical ends)	2.2 dm (0.72 ft)	
Power	0	

E.I. C93A GAS SUPPLY VESSELS (Continued)

Cost

Estimated flight equipment costs are:

Development	\$2K (assuming use of commercial or existing space qualified vessels)
Unit	\$6.4K each (\$12.8K for two)

Development Time: < 1 yr.

E.I. C98A HOLDING UNIT CELLS & TISSUES

Purpose

To house cells and tissues under specified environmental conditions. This unit is similar to an incubator.

Requirements

This equipment item is essentially the common holding unit (see E.I. C99) except that some unique equipment is needed inside in order to hold the cells and tissues organism containers.

Hardware Status

This is a conceptual design item. One prototype for ground based operation has been built by General Dynamics Convair Aerospace.

Technical Description

Estimated properties are:

Weight:	23 kg (50 lb)
Volume:	188 dm^3 (6.64 ft^3)
Power:	50 watts

It should be noted that the weight, power and volume of the common holding unit (E.I. C99) are included in the above values, and should not be added into the carry-on laboratory as a separate item.

Cost

The major development cost of the holding unit for cells and tissues is accounted for in the common holding unit (E.I. C99). The additional development cost for internal equipment peculiar to cells and tissues holding function has been estimated at \$47K. The additional equipment is estimated at \$4K; thus the total unit cost is:

	Unit Cost
Common Holding Unit (E.I. C99)	\$55K
Equipment Peculiar to Cells/Tissues	\$ 4K
Total for Holding Unit, Cells/ Tissues (E.I. C98A)	\$59K

It should be noted that a similar summation procedure cannot validly be carried out to establish a total development cost for the holding unit, cells/tissues.

Development Time - 2 years.

E.I. C98C HOLDING UNIT, INVERTEBRATES

Purpose

To house and provide controlled environmental conditions for invertebrate test organisms.

Requirements

This equipment item is essentially the common holding unit, E.I. C99, except that some unique internal equipment will be required for supporting the invertebrates and related research equipment.

Hardware Status

This is a conceptual design item. One prototype for ground operation and testing has been built by General Dynamics Convair Aerospace Division.

Technical Description

Estimated properties are:

Weight	23 kg (50 lb)
Volume	188 dm^3 (6.64 ft^3)
Power	50 watts

It should be noted that the weight, power and volume of the common holding unit (E.I. C99) are included in the above values, and should not be added into the carry-on laboratory as a separate item.

Cost

The major development cost of the holding unit for invertebrates is accounted for in the common holding unit (E.I. C99). The additional development cost for internal equipment peculiar to invertebrate holding functions has been estimated at \$47K.

The additional equipment unit cost is estimated at \$4K. Thus, the total unit cost is:

E.I. C98C HOLDING UNIT, INVERTEBRATES

	Unit Cost
Common Holding Unit (E.I. C99)	$55K
Equipment Peculiar to Invertebrates	$ 4K
Total for Holding Unit, Invertebrates (E.I. C98C)	$59K

It should be noted that a summation procedure similar to that shown above for unit costs cannot validly be carried out to establish a total for the development cost of the holding unit, invertebrates, see the writeup for E.I. C99.

Development Time: 2 years.

E.I. C101 HOLDING UNIT, PLANTS

Purpose

To hold plants under specified conditions of temperature and humidity and provide light for their growth.

Requirements

Specific requirements have not been determined. General requirements have been discussed for E.I. C99, the common holding unit, which is used as the basic structure of the plant holding unit. Added to the common holding unit are structural support components and a lighting system. The lighting system must include cooling components for the purpose of dissipating the waste heat from the lights.

Hardware Status

This is a conceptual design item. One prototype for ground based operation has been built by General Dynamics Convair Aerospace.

Technical Description

Estimated properties are:

Weight	25 kg (55 lb)
Volume	188 dm^3 (6.64 ft^3)
Power	500 watts

It should be noted that the weight, power and volume of the common holding unit (E.I. C99) are included in the above values, and should not be added into the carry-on laboratory as a separate item.

Cost

The major development cost of the holding unit for plants is accounted for in the common holding unit (E.I. C99). The additional development cost for internal equipment peculiar to plant support has been estimated at $184K.

The unit cost of the peculiar equipment is estimated at $10K; thus the total unit cost is:

E.I. C101 HOLDING UNIT, PLANTS (Continued)

	Unit Cost
Common Holding Unit (E.I. C99)	$55K
Equipment Peculiar to Plants	10K
Total for Holding Unit, Plants	$65K

It should be noted that a summation procedure similar to that shown above for unit costs cannot validly be carried out to establish a total development cost for the plant holding unit, see the writeup for E.I. C99.

Development Time: 2 years.

E.I. C103 HOLDING UNIT, SMALL VERTEBRATES

Purpose

The equipment item provides housing and support to small vertebrates.

Requirements

This holding unit is similar to the common holding unit, E.I. C99. However, the integral temperature control equipment will generally not be needed since the ventilating air flowing into the small vertebrate holding unit will determine the internal temperature. The current organism environmental control system (ECS) baseline is that of an open loop system drawing ventilating air into the holding unit from the cabin. In this case the internal temperature will be approximately equal to that of the cabin. The small vertebrate holding unit will also differ slightly from the common holding unit in its internal structural design peculiar to the support of the small vertebrate cages, E.I. C30A.

Hardware Status

This is a conceptual design item. Several prototype holding units have been built in the past for holding specific organisms for spaceflight, but these designs will probably not be applicable. One prototype for ground based operation has been built by General Dynamics Convair Aerospace and has been used as a basis for the estimated properties given below.

Technical Description

Estimated properties of the small vertebrate holding unit were based on the use of the common holding unit (E.I. C99), less the thermal control equipment. These are:

Weight	13.6 kg (30 lb) (common holding unit, E.I. C99 minus internal thermal control equipment)
Size	66 cm wide x 51 cm high x 56 cm deep (26 x 20 x 22 inches)
Volume	188 dm^3 (6.6 ft^3)
Power	0

These values do not include the small vertebrate cages E.I. C30A which, although removable, will generally be contained within the small vertebrate holding unit. If eight small vertebrate cages (E.I. C30A) are added to the small vertebrate holding unit, the total weight is 32 kg (70.8 lb) and the total power is 72 watts.

E.I. C103 HOLDING UNIT, SMALL VERTEBRATES

Cost

The major development cost of the holding unit for small vertebrates is accounted for in the common holding unit (E.I. C99). Also, the development cost of the cages for the holding unit were estimated to cost $224K. These are included in E.I. C30A.

Unit cost for the small vertebrate holding unit is $55K. Unit cost of the 8 small vertebrate cages which are contained within the holding unit is $28K.

Development Time: 2 years.

E.I. C198 INCUBATOR

Purpose

Growth of bacterial cultures for inflight analysis and preservation with subsequent return to ground.

Requirements

Temperature	236°K (37°C, 99°F)
(Approximate tolerance = ● 0.5°K)	
Internal Volume	3 dm^3 (0.1 ft^3)

Hardware Status

Many commercially available incubators are available, but are generally larger than that required for the COLs. Thus, a custom designed unit will probably be needed. Existing space qualified components can probably be used in the design and fabrication of the incubator.

Technical Description

The incubator is essentially an insulated cabinet with an access door and several shelves. It may be desirable to ventilate the cabinet at a low flow rate and pass the outflow through a contaminant filtering device. This has been assumed to be the case in estimating the following properties.

Weight	5 kg (11 lb)
Volume	8 dm^3 (0.28 ft^3)
Power	5 watts

Cost

Estimated costs are:

Development	$20K
Unit	$ 1K
Commercial	$.2K

Development Time: < 1 yr.

E.I. C199 INFRARED GAS ANALYZER

Purpose

To measure individual gas constituents in gas mixtures.

Requirements

This analyzer is intended to be a small infrared unit with the capability to continuously monitor several specific gases such as CO_2 and CO. By slight modifications and recalibration of the basic analyzer prior to individual flights, several of a variety of gases can be measured depending upon specific experiment requirements.

The sensitivity required for various gases will depend upon the specific experiments. Some experiments will require trace gases to be monitored in the low ppm range. Thus, a highly sensitive IR analyzer would be required.

Hardware Status

Several IR analyzers are commercially available, including the LIRA IR Analyzer and the IR Industries analyzer for which several catalog sheets are are attached. The IR Industries Series 700 analyzer includes readout meters but can be supplied with output voltage devices for connection to other displays. This might be desirable for the carry-on laboratories so that the output signals could be fed into the command and data management subsystem (CDMS). The meter displays could possibly be deleted since the display console of the CDMS could be used for readout. Also, the existing meters might not be qualified to sustain the various launch loads and vibrations.

Technical Description

The weight volume and power requirements of the IR Industries Series 700 analyzer were used as a basis of the flight equipment properties. These are:

Weight	11.3 kg (25 lb)
Size	4.32 x 4.32 x 2.29 dm (17 x 17 x 9 inches)
Volume	42.6 dm^3 (1.51 ft^3)
Power	50 watts

Cost

Estimated flight equipment costs are:

Development	$182K
Unit	$ 10K

E. I. C199 INFRARED GAS ANALYZER (Continued)

The commercial cost of the IR Industries Series 700 analyzer is approximately $2K.

Development Time: 1 yr.

INDUSTRIES, INC

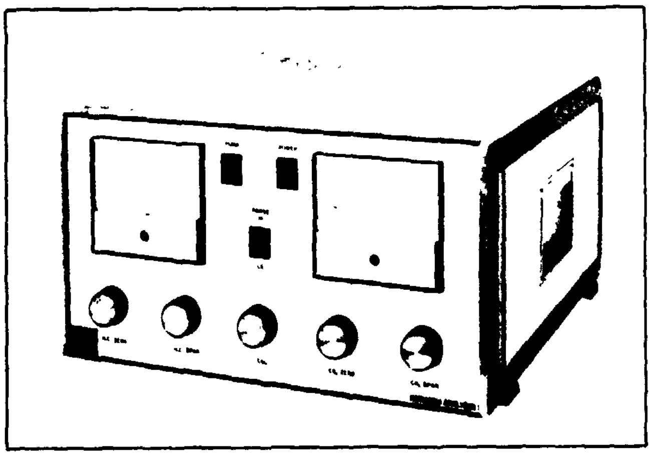
INFRARED INDUSTRIES INC

DATA SHEET

PROCESS INFRARED ANALYZER

NON-DISPERSIVE

- **MULTIPLE GAS MONITORING* WITH SINGLE INSTRUMENT**
- **SOLID STATE ELECTRONICS**
- **DUAL PATH—SEQUENTIAL BEAM**
- **INTERNAL OR SPAN GAS CALIBRATION**
- **FAST WARM-UP—15 MINUTES**



SERIES 700

DESCRIPTION

The Infrared Industries NDIR gas analyzer measures the concentration of gas constituents in a gas mixture by optically sensing the attenuated radiant energy from an infrared source. This measurement is done rapidly, accurately and without contamination or change in the gas being measured. High instrument stability assures maximum user convenience.

Accuracy of the measuring system is assured by precision manufacturing techniques. Infrared is uniquely suited to provide the three primary disciplines required to produce and service these instruments: precision mirrors and filters, detectors specifically designed for this application, and electronics for the data processing function.

Model 700 series is a simple self-contained instrument. The primary outputs are meter displays of the individual gas concentrations. The unit can be supplied with an output voltage suitable for recording systems or can be connected to other devices for linearizing, digitizing, encoding, or numerical display.

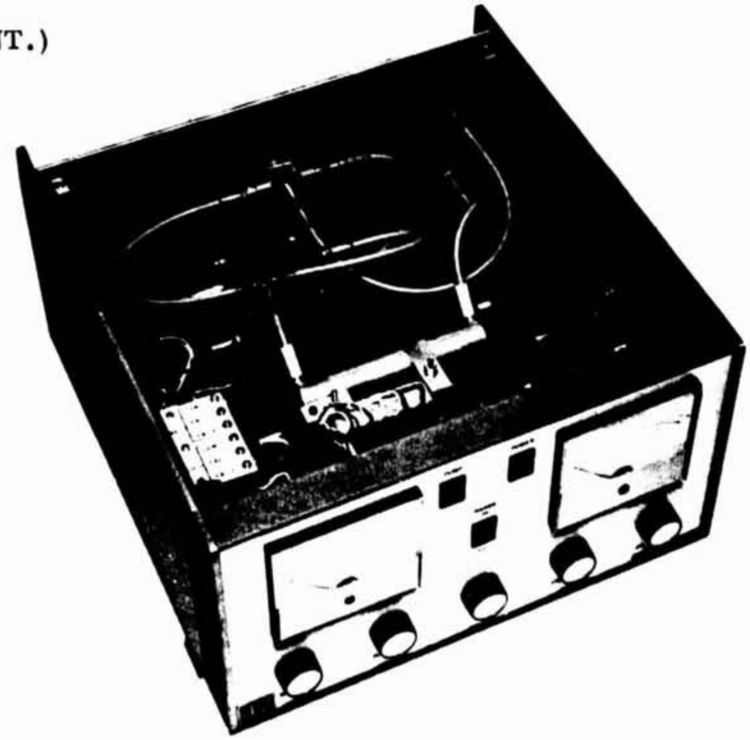
SPECIFICATIONS

CONCENTRATION RANGE: see various model specs (back page)
ACCURACY: 1% of full scale
REPEATABILITY: ±.5% of full scale
SENSITIVITY: 0.2% of full scale
RESPONSE TIME: 5 seconds with 1CFH sample flow

OUTPUTS: 0-100mv
AMBIENT TEMPERATURE: 32°F to 110°F
RELATIVE HUMIDITY: 0-99%
POWER REQUIREMENTS: 115V, 60Hz, 50 watts
ZERO DRIFT: Less than 2%/24 hr
SIZE AND WEIGHT: 17 x 17 x 9, 25 lbs.

*CONSULT FACTORY FOR AVAILABLE COMBINATIONS

INFRARED INDUSTRIES, INC • SANTA BARBARA • CALIFORNIA 93102 • PHONE 805 684-4181



CONSTITUENT GAS SENSITIVITY

RANGE	PARAMETER
0-1% 0-5% 0-10%	CO
0-500 ppm 0-1000 ppm 0-2500 ppm 0-2% 0-5% 0-15%	CO_2
0-500 ppm 0-1000 ppm 0-2000 ppm 0-10,000 ppm 0-5% 0-10%	HC Hexane Equiv.
0-10,000 ppm 0-2% 0-10%	NO
0-10.000 ppm 0-5% 0-10%	SO_2

OPTIONAL FEATURES

Linear Output: Integration of data is frequently required in batch or process applications; however, since all IR Analyzers behave according to Beer's Law, their output is non-linear as a function of concentration. Non-linear signals are difficult to handle accurately in process applications. To permit accurate data integration, a circuit linearizer is available which plugs directly into the instrument.

Optical Calibration: Span gas is eliminated for most applications, thus, lowering the cost of operation significantly. No need to worry about cylinder gas variances or erroneous cylinder labeling.

Corrosion Resistant: Simplifies the job of applying and maintaining the Model 700 on process streams. Materials in contact with sample are 316 stainless steel and Teflon.

DESIGNED FOR APPLICATIONS IN:

Chemical and Petroleum

Carbon Dioxide:	Ethylene Oxide Manufacture, Phthalic Anhydride Manufacture, Ammonia Manufacture, Producer Gas Monitor, Nitrogen Generation.
Acetylene:	Acetylene Manufacture, Acrylonitrile Manufacture, Vinyl Chloride Manufacture.
Surfur Dioxide:	Sulfuric Acid Stack Gas.

Food and Agriculture

Carbon Dioxide and Water Vapor:	Blanketing of Perishables Photosynthesis Studies

Aerospace and Oceanography

Carbon Dioxide, Carbon Monoxide and Water Vapor:	Diving and Space Chambers

Medical

Carbon Dioxide:	Respiratory Studies.
Carbon Monoxide:	Clinical Pulmonary Diffusing Capacity.
Various Anesthetics:	Anesthesia.

Metals and Ceramics

Carbon Dioxide:	Producer Gas Monitor, Steel Converting, Cement Manufacture, Soaking Pit, Heat Treating.
Carbon Monoxide:	Inert Gas Generation, Producer Gas Monitor, Rotary Kiln Roasting, Tin Plant Annealing, Steel Converting, Aluminum Powder Processing, Porcelain Tunnel Kilns.
Water Vapor:	Heat Treating, Hydrogen Brazing, Nickel and Chrome Plating.
Sulfur Dioxide:	Flash Smelting.

E.I. C200 KIT, ANIMAL PHYSIOLOGY

Purpose

To provide tools and small hardware for setting up and conducting physiological measurements on animals.

Requirements

Specific requirements have yet to be determined and will be somewhat experiment specific. Also, for the short duration missions, much of the preparation for physiological measurements will be performed prior to flight. Organisms to be considered include small vertebrates and certain species of invertebrates.

Hardware Status

Most of the items used in ground applications should be suitable for use in space.

Technical Description

Some typical items in this kit are listed below along with preliminary estimates of weight, power, and volume.

Item	Quantity	grams	watts	cc
Biobackpack, micro	2	25	0	25
Chloral Hydrate	1	25	0	25
Electrodes, ECG, EEG, etc.	20	10	0	50
Flowmeter, Doppler, Blood	1	450	1	250
Harness, Electrophysiology, Small	2	25	0	25
Nembutal	1	25	0	25
Respirometer, Strain Gage	2	[illegible]	negl.	500
Thermistor, Deep Body Temp.	2	25	negl.	25
Transducer, Venous Press. Implantable	1	5	negl.	5
Totals		640	1	930

Preliminary estimates for the total weight, power, and volume of the animal physiology kit for the COLs are shown below. These values would be applicable for both 7 and 30 day missions since the change in consumables is negligible.

Weight	1.5 kg (3.3 lb)
Power	Negligible
Volume	2 dm^3 (0.07 ft^3)

Cost

Estimated costs for this kit are:

Development	$18K
Unit	$ 2K

Development Time: < 1 year.

E.I. C210 KIT, BLOOD ACQUISITION

Purpose

To provide for collecting, transferring and storing human blood samples

Requirements

This kit is intended to satisfy the requirements of the small Category C (50 lb weight limited) carry-on laboratories (see Volume II of this report). It contains a portion of the items listed under the hematology kit (E.I. C106).

Hardware Status

Commercial equipment should be usable. Liquids may require special containers and handling equipment. Breakable items should not be used.

Technical Description

The following list of items was used in establishing the preliminary characteristics of the blood acquisition kit. The list is exemplary only and may change as specific research requirements become known. Weight, volume, and power estimates are shown for each item.

Item	Quantity	grams	watts	cc
Alcohol, Ethanol	2	200	0	200
Band Aids	25	25	0	50
Cotton Swabs	50	25	0	500
Hemoglobinometer, Spencer	1	400	0	1500
Lancets	20	10	0	25
Needles	25	5		5
Slides, Microscope (pre-stained)	30	150	0	150
Syringes	10	400	0	400
Tourniquet	1	50	0	50
Totals		1265	0	2880

The total 7-day weight and volume of this kit for purposes of conceptual design were assumed to be:

Weight: 1.4 kg (3.1 lb)
Volume: 3.1 dm^3 (0.11 ft^3)

E.I. C210 KIT, BLOOD ACQUISITION (CONT'D)

Cost

Estimated costs are:

Development:	$4K
Unit:	$0.7K

Development Time: < 1 yr.

E.I. C201 KIT, CHEMICAL SAMPLING

Purpose

To provide the equipment for transferring and managing chemicals during various manual LSPS experiment procedures.

Requirements

This kit will be used for transferring gaseous liquid and solid samples to and from experiment equipment. Chemicals may have to be injected into various equipment components, specimens may be transferred to the refrigerator for storage and later ground analysis, chemicals may be transferred from one part of the experiment apparatus to another or to experiment specific analysis equipment such as a conductivity meter. Gas samples may require manual transfer from the experiment equipment to the gas analyzers.

In general, such procedures are expected to involve quantities on the order of 1 to 100 cc. Syringes will probably be used for most gas and liquid transfers.

Hardware Status

Most of the equipment needed will require minor development for use in zero-g.

Technical Description

This kit is estimated to weigh 4.5 kg (10 lb) and occupy 14.2 dm^3 (.5 ft^3) for a 30-day mission. For seven days, the weight was estimated at 1.5 kg (3.3 lb) and the [illegible] at 5 dm^3 (0.18 ft^3). The kit will contain such items as syringes, vials, bottles, test tubes, chemicals, leak detector fluid, stoppers, sponges, forceps, scissors, plastic bags, etc.

Cost

Estimates for a flight kit are:

Development	$5K
Unit	$.5K

Development Time: < 1 yr.

E.I. C106A KIT, CLEAN-UP

Purpose

To facilitate manual clean-up procedures around the COLs.

Requirements

The kit should provide the general equipment and materials to clean up both liquid and solid debris. These kits may be used during the experiments as well as at their termination.

Hardware Status

Commercially available materials should be usable.

Technical Description

This kit may include sponges, dry wipes, chemically pre-moistened wipes, towels, swabs, disinfectant, plastic bags, plastic liners, etc. The weight and volume were estimated as follows for conceptual design purposes:

	7-Day Mission	30-Day Mission
Weight	1.5 kg (3.3 lb)	3 kg (6.6 lb)
Volume	4 dm^3 (0.18 ft^3)	8 dm^3 (0.35 ft^3)
Power	0	0

Cost

Estimated costs are:

Development	$40K
Unit	$ 4K

Development Time: < 1 yr.

E.I. C113, KIT, GENERAL TOOL

Purpose

This kit includes the mechanical and electrical tools and hardware to provide conventional diagnostic, maintenance, and service functions. It should be noted that most maintenance functions will be of a remove and replace nature.

Requirements

The specific requirements of this kit will depend upon the experiments being performed. The kit inventory may be changed to suit individual flights and experiments. This kit may also be supplemented by a general tool kit aboard the supporting spacecraft.

Hardware Status

Some tools will require some design modification for efficient use in the 0-g environment. Others will be usable as is.

Technical Description

The kit will probably include the following 0-g type tools:

Hammer	Lubricants
Wrenches	Flashlight
Pliers	Scissors
Tape	Clamps
Wire Cutters	Lamp
Wire Ties	Tubing
	Fasteners
	etc.

The properties of this kit are estimated below:

Weight:	4.5 Kg (10 lbs)
Volume:	14.2 dm^3 (0.5 ft^3)
Power :	50 watts (for trouble light)

Cost

Development	$16K
Unit	$1.4K

Development Time

One year

E.I. C106 KIT, HEMATOLOGY

Purpose

To provide for collecting, transferring, processing, and analyzing blood.

Requirements

The requirements of the equipment within this kit will vary depending upon the specific experiments. They will also vary somewhat, depending upon the organism from which blood is being collected. For purposes of conceptual design, equipment used for human blood collection were used as a basis for estimating the contents of this kit.

Hardware Status

Commercial equipment should be usable. Liquids will require special containers and handling equipment. Some equipment designed for space and used on Skylab may also be applicable, such as the special 0-g blood collection and processing syringes.

Technical Description

The following is a representative list of items along with approximate weight, power, and volume for a 7-day mission.

Item	Quantity	grams	watts	cc
Alcohol, Ethanol	2	200	0	200
Alcohol Swabs	50	25	0	500
Band-Aids	25	25	0	50
Counter, Differential	1	1200	0	1000
Counter, Tally	1	50	0	50
Cover Slip (Counting Cmbr)		negl.	0	negl.
Critoseal, Clay Sealant	1	50	0	10
Gauze (2x2) & Sponges	100	50	0	300
Hemacytometer	1	100	0	300
Hemoglobinometer, Manual	1	400	0	1500
Labstix (Glu, Alb, Bld, pH, Ket, etc.)	100	25	0	100
Lancets	20	10	0	25
Luer Adapters, Vacutainer	30	50	0	10
Needles, Vacutainer (21 ga., 26 ga.)	40	10	0	10
Pipettes, Blood Diluting	30	50	0	50
Pipettes, Disposable, #10 Lambda	30	10	0	25
Pipettes, Oxford Sampler (with 100 tips)	2	50	0	100
Slides, Microscope (pre-stained)	50	250	0	200
Syringes, Special 0-g, Blood	10	400	0	400

E.I. C106 KIT, HEMATOLOGY (Continued)

Item	Quantity	grams	watts	cc
Syringes, Vacutainer	40	400	0	400
Tourniquet	1	50	0	50
Tubes, Microhet, Heparinixed	30	20	0	50
Tubes, Microhet, Plain	30	20	0	50
Tubes, Vacutainer, Assorted	20	20	0	50
Totals		3465	0	5430

The total weight and volume of this kit for conceptual design analysis was assumed to be:

	7-Day Mission	30-Day Mission
Weight	4 kg (8.8 lb)	8 kg (17.6 lb)
Volume	6 dm^3 (0.21 ft^3)	12 dm^3 (0.42 ft^3)
Power	0	

Cost

Estimated costs are:

Development	$74K
Unit	$ 6K

Development Time: 1 yr.

E.I. C108 KIT, HISTOLOGY

Purpose

To provide small equipment and reagents necessary for the preparation and preservation of small tissue samples (plant and animal).

Requirements

To be determined.

Hardware Status

The use of liquids (stains, fixatives, etc.) may require special procedures and equipment.

Technical Description

The following are estimates of the weight and volume of exemplary items which would be included in the histology kit for a 7-day mission.

Item	Quantity	grams	watts	cc
Fixative, Ethanol	1	100	0	100
Fixative, Formalin	1	100	0	100
Fixative, Zenkers Soln.	1	100	0	100
Forceps, Tissue (Rattooth), Michel	2	25	0	25
Pipettes, Oxford Sampler	2	50	0	100
Stains, Assorted	4	200	0	200
Totals		575		625

The total weight and volume of the histology kit, for conceptual design purposes, was assumed to be:

	7-Day Mission	30-Day Mission
Weight	1.0 kg (2.2 lb)	3 kg (6.6 lb)
Volume	1 dm^3 (0.04 ft^3)	3 dm^3 (0.11 ft^3)

Cost

Estimated costs are:

Development	\$8K
Unit	\$0.7K

Development Time: < 1 yr.

E.I. C110C KIT, HUMAN PHYSIOLOGY

Purpose

To provide necessary small equipment items for physiological measurements.

Requirements

Specific requirements have yet to be determined. This kit will be used to support both biomedical and MSI experiments.

Hardware Status

Most of this equipment can be of the commercial type used on the ground.

Technical Description

Representative equipment items and preliminary estimates of weight, power, and volume are listed below:

Item	Quantity	grams	watts	cc
Counter, Tally	1	50	0	50
Cuff, Blood Pressure	1	1000	0	300
Electrodes, ECG, VCG, etc., Disposable	20	10	0	50
Flowmeter, Doppler, Blood	1	450	1	250
Harness, Electrophysiology	1	450	0	3000
Labstix (Glu, Alb, Blood, pH, Ketone)	100	50	0	100
Oto-Opthalmascope (Battery)	1	150	0	350
Respirometer, Strain Gage	2	50	0	500
Sphygmomanometer	1	300	0	500
Spiror eter Mouthpieces	3	50	0	500
Stethescope	1	100	0	600
Thermistor, Deep Body Temp.	2	50	0	50
Thermometer, Oral	4	50	0	25
Tuning Fork	1	100	0	200
Totals		2860	1	6475

For conceptual design definition purposes, the total weight, power, and volume of the human physiology kit was estimated at:

Weight	3 kg (6.6 lb)
Power	negl.
Volume	8 dm^3 (0.28 ft^3)

E.I. C110C KIT, HUMAN PHYSIOLOGY (Continued)

Cost

Estimated costs for a flight kit are:

Development	\$16K
Unit	\$1.6K

Development Time: < 1 year.

E.I. C110 KIT, MICROBIOLOGY
(Routine Biosampling and Contaminant Monitoring)

Purpose

To provide tools to facilitate growing and analyzing microbial organisms.

Requirements

To be determined.

Hardware Status

Most ground-based commercial equipment should be usable in space.

Technical Description

The following is a representative list of items needed in a microbiology kit.

Item	Quantity	grams	watts	cc
Alcohol, Ethanol	1	50	0	50
Counter, Tally	1	50	0	50
Loop, Inoculating	2	10	0	20
Media, Blood Agar, Plated	7	100	0	200
Media, Emb Agar, Plated	7	100	0	200
Media, Phenylethyl Alcohol	7	100	0	200
Media, Stuart Transport	7	100	0	200
Media, TSA Agar, Plated	7	100	0	200
Needles, Inoculating	2	10	0	10
Pipettes, Oxford Sampler	2	50	0	100
Slides, Microscope	50	200	0	200
Swabs, Cotton	50	25	0	500
Syringe, 5 ml, sterile	1	10	0	10
Thioglycollate, tubed	7	50	0	50
TSA Slants	7	50	0	50
Tubes, 15 x 75 mm, sterile	10	50	0	150
Zephiran, Tincture, 1:500	1	50	0	50
Totals		1105	0	2240

The total weight, power, and volume values assumed for conceptual design purposes were:

	7-Day Mission	30-Day Mission
Weight	2 kg (4.4 lb)	6 kg (13.2 lb)
Power	0	0
Volume	3 dm^3 (0.11 ft^3)	8 dm^3 (0.28 ft^3)

E.I. C110 KIT, MICROBIOLOGY (Continued)

Cost

Estimated flight kit costs are:

Development	$17.7K
Unit	1.5K

Development Time: 1 yr.

E.I. C114A KIT, MICRODISSECTION

Purpose

This kit provides small equipment for surgical procedures on small organisms.

Requirements

Procedures to be performed may include surgery on small animals for purposes of collecting tissue samples and other specimens, or implanting sensors. Specimen collection from plants, invertebrates, and amphibians may be required. Other specific requirements have yet to be determined.

Hardware Status

Commercially available - minor modifications may be required.

Technical Description

Representative components along with their estimated weight and volume are listed below:

Item	Quantity	grams	watts	cc
Blades, Surgical	25	25	0	10
Chloral Hydrate	1	25	0	25
Forceps, Gilbert	2	20	0	20
Forceps, Needle, Metzenbaum	2	20	0	20
Knife Holder, Bard Parker	2	50	0	10
Microsurgery Set	1	450	0	1000
Needles, Assorted	15	25	0	25
Needles, Suture, Assorted	15	25	0	25
Nembutal	1	25	0	25
Retractor, Weitlaner	20	10	0	10
Scissors, Mayo-Nobel, Dissecting	2	50	0	25
Scissors, Operating	2	50	0	25
Suture Material, Monofilament	1	5	0	10
Totals (Exemplary Equipment)		780	0	1230

The following total weight and volume were assumed for conceptual design purposes for both 7- and 30-day missions:

Weight	1 kg (2.2 lb)
Volume	2.0 dm^3 (0.07 ft^3)
Power	0

E. I. C114A KIT, MICRODISSECTION (Continued)

Cost

Estimated costs are:

Development	$13K
Unit	$1K

Development Time: < 1 yr.

E.I. C211 KIT, PHYSICAL EXAMINATION

Purpose

To provide the necessary items for simple human physical examinations.

Requirements

This kit is limited in its contents in order to satisfy the requirements of the small Category C carry-on laboratories (see Volume II of this report). It contains some, but not all, of the items contained in the human physiology kit (E.I. 110C) which is used in the larger carry-on laboratories.

Hardware Status

Commercial equipment should be usable in most cases.

Technical Description

The following list of items was used in establishing the preliminary characteristics of this kit. The list is exemplary only, and may change as specific research requirements become known. Weight, power and volume estimates are shown for each item.

Item	Quantity	grams	watts	cc
Cuff, Blood Pressure	1	1000	0	300
Flowmeter, Doppler, Blood	1	450	0	250
Oto-opthalmascope	1	150	0	350
Stethoscope	1	100	0	600
Thermometer	4	50	0	25
Tuning Fork	1	100	0	200
Totals		1850	0	1725

The total 7-day weight and size of this kit for purposes of conceptual design was assumed to be:

Weight:	2 kg (4.4 lb)
Size:	10×10×31 cm (4×4×12 inches)
Volume:	3.1 dm^3 (0.11 ft^3)

E.I. C211 KIT, PHYSICAL EXAMINATION (CONT'D)

<u>Cost</u>

Estimated costs are:

Development:	\$3K
Unit	\$3.6K

<u>Development Time</u>: < 1 yr.

E.I. C111 KIT, PLANT MANAGEMENT

Purpose

This kit provides tools and components for various plant research procedures.

Requirements

To be determined.

Hardware Status

Commercially available ground-based equipment should be applicable with slight modifications.

Technical Description

Representative components of this kit are listed below.

Item	Quantity	grams	watts	cc
Applicator	10	20	0	20
Blades, Surgical	25	25	0	10
Forceps, Gilbert	2	20	0	20
Forceps, Splinter	2	20	0	20
Knife Holder, Bard Parker	2	50	0	10
Needles, Syringe	20	10	0	10
Scissors, Mayo-Nobel Dissection	2	20	0	10
Scalers	3	5	0	10
Spatulas	10	20	0	20
Splints	8	20	0	20
Squib Firing Mechanism	1	50	0	25
Squibs (Plant Growth Arrester)	10	50	0	25
Syringes	10	50	0	50
Tape	1	50	0	50
Totals (Exemplary Equipment)		410	0	300

The total weight, power and volume for this kit were assumed to be:

	7-Day Mission	30-Day Mission
Weight	1 kg (2.2 lb)	2 kg (4.4 lb)
Power	0	0
Volume	1 dm^3 (0.04 ft^3)	2 dm^3 (0.07 ft^3)

E.I. C111 KIT, PLANT MANAGEMENT (Continued)

<u>Cost</u>

Estimated costs are:

Development	$10.5K
Unit	$0.9K

<u>Development Time:</u> < 1 yr.

E.I. 212 KIT, URINE ACQUISITION

Purpose

To provide the necessary equipment for the collection, transfer, and storage of human urine.

Requirements

This kit is intended for use in the small Category C (50 lb weight limited) biomedical COLs described in Volume II of this report. This kit contains some of the same items which are contained in the larger hematology kit which is used for the Category A&B COLs.

Hardware Status

Commercial equipment should be usable. Liquid handling equipment may require modification for use in zero-g.

Technical Description

The following list of items was used in establishing the characteristics of this kit for conceptual design purposes. The list may change as specific research procedures are defined. The weight, power and volume of each item are included in the list.

Item	Quantity	grams	watts	cc
Labstix	50	15		50
Needles	25	5		5
Syringes, 200 cc	3	300		900
Urine Storage Bags	25	500		1000
Totals		820		1955

The total 7-day weight and size of this kit for conceptual design purposes was taken as:

Weight:	0.9 kg (2 lb)
Size:	10×10×31 cm (4×4×12 inches)
Volume:	3.1 dm^3 (0.11 ft^3)

E.I. 212 KIT, URINE ACQUISITION (CONT'D)

Cost

Estimated costs are:

Development:	$2.5K
Unit:	$0.1K

Development Time: < 1 yr.

E.I. C110B KIT, VERTEBRATE MANAGEMENT

Purpose

To provide tools and devices used in the handling of vertebrates.

Requirements

The contents of this kit will depend upon the experiments being conducted and the specific organisms being used.

Hardware Status

Ground-based equipment with minor modifications is generally applicable.

Technical Description

This kit was assumed to include 20 plastic bags, 10 towels, an organism transfer/restraint capsule, 12 animal tags, 4 organism harness-type restraints, and a universal animal dissection board. Estimated weight and volume for this kit for both 7- and 30-day missions are approximately:

Weight:	3 kg (6.6 lb)
Volume:	6 dm^3 (0.21 ft^3)

Cost

Estimated flight kit costs are:

Development:	\$13K
Unit:	\$1.1K

Development Time: 1 year.

E.I. C202 LAMP, PORTABLE HIGH INTENSITY PHOTO

Purpose

Illumination of subjects during photographic or still documentation

Requirements

To be determined.

Hardware Status

A photographic lamp is currently being built for Shuttle by Sylvania. It was assumed herein that the Shuttle lamp would be usable on the carry-on laboratories.

Technical Description

The weight and power of this lamp was estimated based on a previous lamp used on Skylab which weighed 6.26 kg (13.8 lb) and used 150 watts. The volume was estimated at 6 dm^3 (0.21 ft^3), stowed.

Cost

Estimated costs are:

Development	\$0K
Unit	\$3K

Development Time: 1 yr.

E.I. C203 LIQUID TANK

Purpose

To provide for storage of liquids during LSPS equipment testing. Both fresh liquids and waste liquids may need to be stored.

Requirements

This tank will require positive expulsion provisions and will usually contain water, or other relatively inert liquids. Acidic, corrosive, or otherwise reactive liquids were assumed to be contained in experiment specific tanks. The capacity of a single common use liquid tank for the LSPS COLs was assumed to be 15 dm^3 (0.53 ft^3 or 3.96 gal.). The same basic tank could serve for fresh liquid storage or waste liquid storage.

Hardware Status

Flight qualified liquid designs are available and should be reviewed for possible configurations suitable for the COL.

Technical Description

Estimated tank properties are:

Weight

Empty Tank	1.5 kg (3.31 lb)
Water	15 kg (33.1 lb)
Total	16.5 kg (36.4 lb)

Volume 16.5 dm^3 (0.583 ft^3)

Power 0

Cost

Estimated flight equipment costs are:

Development	$56K
Unit	$6.5K

Development Time: 1 yr.

E.I. C116 LOG BOOKS

Purpose

To write down experiment notes, results, procedures and comments.

Requirements

A standard type note book with a 0-g hold-down device should be acceptable.

Hardware Status

Log books of the type used in previous space flights should be available.

Technical Description

Estimated weight and volume requirements for 7 days are:

Weight: 0.5 kg (1.1 lb)

Volume: 0.4 dm^3 (0.014 ft^3)

Cost

Development: $0.5K

Unit : $0.1K

Development Time

Negl.

E.I. C122 MASS MEASUREMENT DEVICE

Purpose

To measure the mass of solids and liquids associated with LSPS testing.

Requirements

Specific requirements have yet to be determined. For the carry-on laboratories (COLs) a mass measurement range of 100 mg to 100 g was assumed to be adequate. This range, reportedly, can be accommodated by the experimental measurement device aboard Skylab (Experiment MO74).

Hardware Status

The Skylab mass measurement device was assumed to be available. This device operates using an oscillatory principle for the mass determination. The measurement of liquid samples (if required) will require special containers to prevent liquid sloshing during the mass determinations. Also, other non-solid specimens will require a restraint device during the mass determination.

Technical Description

The following properties are for the Skylab mass measurement device.

Range	0 to 1.0 kg
Accuracy	± 1 mg
Weight	15.9 kg (35 lb)
Power	7 watts (1/4 amp @ 28 volts dc)
Volume	20 dm^3 (0.71 ft^3) (estimated)

Cost

Based on using the Skylab type of mass measurement device costs are:

Development	$0
Unit	$5K

Development Time: 0

E.I. C91 MASS SPECTROMETER

Purpose

To measure concentrations of individual gases in gas mixtures.

Requirements

Requirements will depend upon the specific experimental equipment being tested. Common gases which require monitoring include O_2, N_2, H_2, CO_2, CO, CH_4, H_2O, NH_3, and He. In addition, atmospheric trace constituents will probably need to be measured. The mass spectrometer may be combined with the gas chromatograph being used to separate components such as CO and N_2 which have the same mass number, and the mass spectrometer providing the sensitivity to measure trace gases in the parts-per-million range.

Hardware Status

Commercial units are available but would require modifications such as alteration to operate on 28 volt d.c. power. A number of mass spectrometers for space-flight and aircraft applications have been built by Perkin Elmer, Aerospace Division. These include one for the Skylab metabolic analyzer and one for the Viking Mars probe. The latter operates in conjunction with the gas chromatograph and will measure trace constituents in the 0.5 to 50 ppm range. A prototype of a third mass spectrometer system similar to the Viking unit was built for NASA/LRC, and was devoted to trace contaminant monitoring. The data used herein was based upon the use of this system, which is referred to as the trace contaminant sensor system by Perkin Elmer. This system would have to be designed for manual as well as automatic operation, and would also require a slight modification to enable it to measure gases at high concentrations and low mass numbers as well as gases at trace concentration levels.

Technical Description

The following are estimates for the Perkin Elmer flight type trace contaminant sensor system. In addition to the mass spectrometer, this system includes an inlet system containing various sorbents for the purpose of isolating the individual gaseous constituents to be measured. The system utilizes a built-in programmer for the adsorption and desorption of the sorbent beds. The estimated properties of this system, according to Perkin Elmer, are:

E.I. C91 MASS SPECTROMETER (Continued)

Weight	11.3 kg (25 l)
Volume:	16.4 dm^3 (0.58 ft^3)
Power:	30 watts average

The system does not require any consumable resupplies over time periods on the order of 30 days. It must be connected to a vacuum source (E.I. 118I), the gas sample source, and the supporting vehicle command and data management subsystem.

Cost

Estimated costs for the mass spectrometer system are:

Development	$100K
Unit	$100K

Development Time: 1 Year

E.I. C126B MICROPHONE

Purpose

The microphone is used in the laboratory for: (1) monitoring background noise, and recording the sounds and speech of human subjects during test

Requirements

No unique requirements are anticipated, beyond a reasonably flat frequency response in the audible range. Several different types might be useful, including omni-directional for background noise, uni-directional for subject monitoring and lavalier (neck cord) for subject monitoring or data recording. The microphone should be compatable with the Sony Videocorder VC-2200, EI C207.

Hardware Status

Off-the-shelf hardware should be suitable.

Technical Description

Many suitable microphones are available. The following properties are estimates of average properties including mounting bracket:

Weight - 0.5 Kg (1.1 lb)
Volume - .5dm^3 (.02 ft^3)
Power - Negligible

Cost

Development: $1K
Unit : $0.2K

Development Time

Negl.

E.I. C126 MICROSCOPE, COMPOUND

Purpose

To provide the exper'menter with a general purpose binocular microscope for microscopy studies . . tissues, etc. To permit the taking of photographs of selected specimens at the same time.

Requirements

Magnification	10 × to 100 ×
Binocular construction	
Photographic capability with 35 mm roll film	
Lighting:	Dark field or Light field and phase contrast

Hardware Status

Commercial equipment should be usable. Lights may have to be changed for use of 28 volt power and weight could possibly be reduced. An existing model of American Optical Co.; Series 20 Microstar, Model No. XH20TG-0W is an example of a possible microscope for use. Literature on this microscope is attached.

Technical Description

Estimated properties are:

Weight	11 kg (25 lbs)
Volume	28 dm^3 (1.0 ft^3)
Power	50 W (illumination)

Cost

Estimated costs for a flight unit are:

Development	\$2K
Unit	\$3.5K

Development Time: < 1 yr.

A research-type illuminator makes the Series 20 Advanced Microscope ideal for investigative and diagnostic microscopy. Superior illumination and the edge to edge field flatness obtained through infinity corrected optics provide the right combination for photomicrography, viewing screen observation and phase contrast. The illuminator source is a high-intensity quartz halogen lamp. Built-in filters give complete flexibility in the selection of transmission levels and color temperatures. The illuminating system is housed in a large, cast aluminum base that gives maximum stability. A variable transformer is furnished for operation of the 12-volt lamp at 9 volts, 10.5 volts or 12 volts, to suit viewing requirements.

The 100-watt quartz-halogen lamp provides light of exceptional spectral purity. This excellent lighting assures dependable color photography. Centerable field diaphragm also enables the microscopist to obtain highly desirable Koehler illumination for photographic applications. The two built-in filter turrets allow convenient selection of filter combinations.

Top filter turret holds 1 clear aperture, 3 neutral density filters of 5%, 25% and 50% transmission, and a didymium color balancing filter. The lower turret contains 1 blue daylight filter, 1 heavy blue filter for Polacolor, 1 Wratten 80A plus CC10R for color transparencies, 1 green filter for phase microscopy and black and white photography, and 1 clear aperture. Access door lets you change filters or insert new ones in extra locations provided.

The basic microscope consists of an inclined trinocular body, with pair of 10X widefield eyepieces, rotatable 360° in the rigid, one-piece stand. Lightweight focusable, quadruple nosepiece has 4X, 10X, 45X and 100X objectives; focusing with the dual, low-position coaxial coarse and fine adjustments. Fixed stage releases with lever for an additional 1⅝" clearance when required. Substage equipment includes rack and pinion, fork-type condenser mount, N.A. 1.25 condenser. For 115 VAC, 60 Hz.

Cat. No.	AO Model	Stage	Body	Each
41711-407	XH20BU-QW	Ungrad. Mech.	Binoc	**1500.00**
41711-451	XH20TU-QW	Ungrad. Mech.	Trinoc	**1550.00**
41711-509	XH20TG-OW	Grad.	Trinoc	**1576.00**

E.1. C126A MICROSCOPE, DISSECTING

Purpose

To permit dissecting of biological specimens such as plants, animal tissue and organs.

Requirements

Stereo eyepiece head
Adjustable bright and dark field illumination

Hardware Status

Commercial units are available with zoom or trinocular heads for simultaneous viewing and photography. Minor modifications will be required.

Technical Description

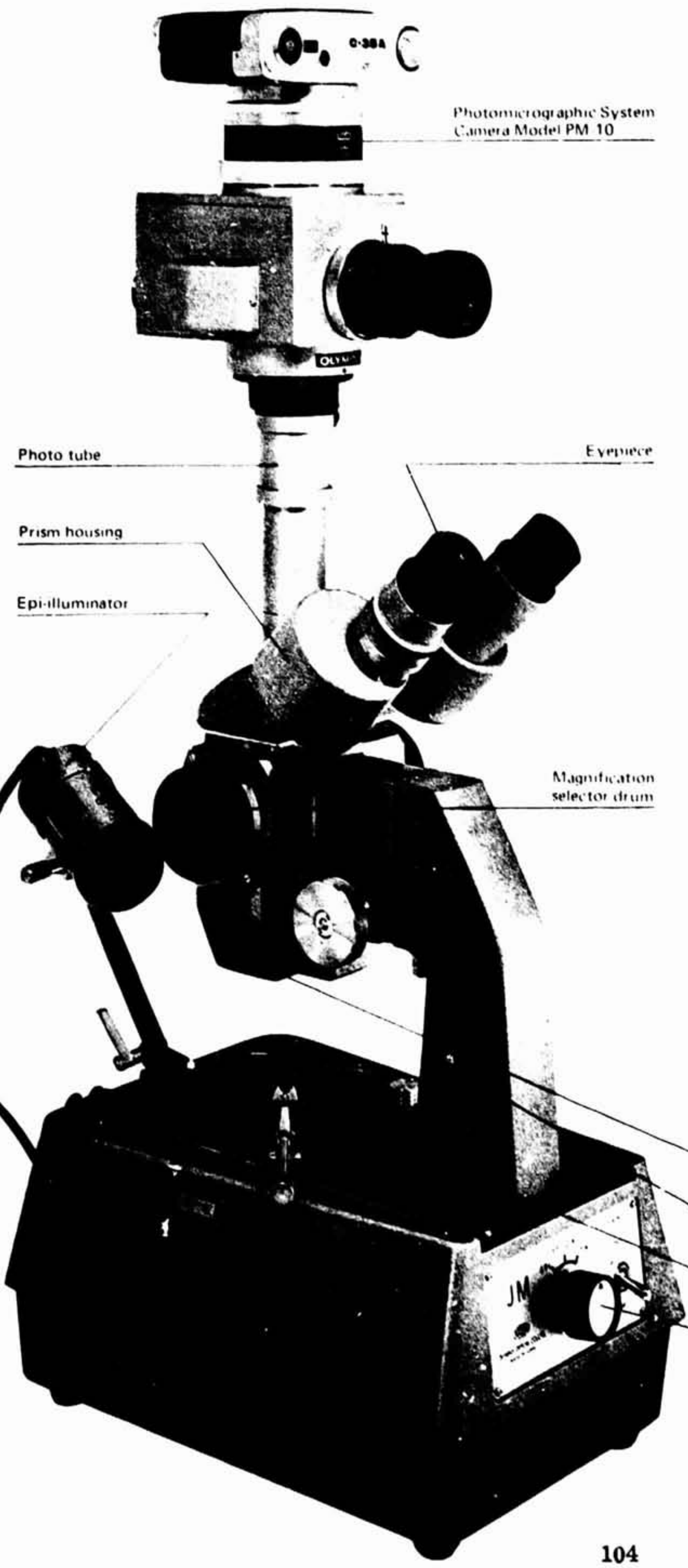
Estimates for flight equipment are:

Weight	9 kg (20 lbs)
Volume	28 dm^3 (1 ft^3)
Power	63 watts

Cost

Commercial microscopes shown in the attached sheets cost approximately $1K each. Estimated development and unit costs for flight equipment are $1K and $2K, respectively.

Development Time: < 1 yr.



OLYMPUS DARKFIELD STEREO MICROSCOPE

MODEL JM-Tr

The JM-Tr, thanks to its unique trinocular optical system, allows photographs to be taken at any time, with no interruption in viewing and no need to re-focus.
In every field where stereoscopic examination and photomicrographic documentation is required the trinocular darkfield stereo microscope JM-Tr presents significant advantages.
The convenient trinocular tube consists of a binocular tube inclined 45° and a vertical photo tube for photomicrographic, cinematographic or television work.
The total visual magnification with the new turret 5-step magnification changer ranges from 6.3× to 80×, for photography from 6.3× to 40× with the standard photo eyepiece P10× for both viewing and photomicrography.
A collapsible leg is provided beneath the base for changing the position of the observer's eye point or the inclination angle of the observation tube for observer comfort.
The aperture iris diaphragm on the stage is adjustable between 2mm and 40mm diameters for control of transmitted-illumination.
Photographic accessories available include 35mm, 3¼"×4¼" Polaroid® and 4"×5" sheet film cameras, a viewing screen, and a combination exposure/color-temperature meter. These photo accessories require use of flat-field P7×, P10× or P15× photo eyepieces.

® "Polaroid" is a registered trade mark of the Polaroid Corporation, Cambridge, Massachusetts, U.S.A.

Specifications

	JM	JM-Tr
Main Body	Binocular tube, inclined 45°, rotatable 360°, with locking screw. For maximum observer comfort 60° eyepiece tube is available on special order. Angle of visual axes is 12° for optimum image coincidence. Zoom ratio 5.7 : 1	Trinocular tube, including 45°-inclined binocular tube with locking screw plus vertical photo tube. Prism housings geared together. Angle of visual axes is 12° for optimum image coincidence. Auxiliary magnifiers are incorporated on a built-in revolving turret; for easy choice of total magnifications of 6.3×, 10×, 16×, 25× and 40× with standard G10× eyepiece.
Interpupillary Adjustment	With G10× eyepiece: 53mm-79mm (2.09"-3.11") With G20× eyepiece: 49.5mm-75.5mm (1.95"-2.97")	With G10× eyepiece: 50mm-80mm (1.97"-3.15") With G20× eyepiece: 46mm-80mm (1.81"-3.15")
Diopter Adjustment	±2.5 diopters on each eyepiece tube, accommodating individual eye differences up to 5 diopters.	
Total Magnification	14×—80×	6.3×—80×
Focusing	By vertical movement in a range of 55mm (2.17"). Focusing by diagonal-cut rack and pinion; tension adjustable by counter-rotation of right- and left-hand focusing knobs.	By vertical movement in a range of 38mm (1.50") by rack and pinion.
Illuminators	Built-in 20 watt transmitted illuminator with brightfield-darkfield selector switch, available or 100V, 120V, 220V or 240V. The diameter of the aperture iris diaphragm is continuously variable from 2mm to 40mm (0.09" to 1.57"). A 12 watt epi-illuminator, built on a swivel-joint arm with focus adjustment, may be used individually or simultaneously for oblique illumination.	
Working Distance	88mm (3.46")	86mm (3.39")

Optical Data: Model JM

Auxiliary Objectives	Working Distance mm (inch)	G10× Eyepiece	G15× Eyepiece (Optional)	G20× Eyepiece	Field of View: With G10×	Field of View: With G15× (Optional)	Field of View: With G20×
1×	88mm (3.46")	7×-40×	10.5×-60×	14×-80×	31.4-5.5mm (1.24"-0.22")	18.8-3.25mm (0.74"-0.13")	17.4-3.1mm (0.69"-0.12")
0.5×	159mm (6.26")	3.5×-20×	5.25×-30×	7×-40×	62.9-11.0mm (2.48"-0.43")	37.1-6.5mm (1.46"-0.26")	34.8-6.1mm (1.37"-0.24")
0.75×	105mm (4.13")	5.25×-30×	7.875×-45×	10.5×-60×	41.9-7.3mm (1.65"-0.29")	24.7-4.3mm (0.97"-0.17")	23.2-4.1mm (0.91"-0.16")
1.5×	45mm (1.77")	10.5×-60×	15.75×-40×	21×-120×	20.95-3.7mm (0.82"-0.15")	12.3-2.2mm (0.48"-0.09")	11.6-2.0mm (0.46"-0.08")
2×	30mm (1.18")	14×-80×	21×-120×	28×-160×	15.7-2.75mm (0.62"-0.11")	9.3-1.6mm (0.37"-0.06")	8.7-1.5mm (0.34"-0.06")

Model JM-Tr

Objective \ Eyepiece	G10× Magnification	G10× Field of View	G15× (Optional) Magnification	G15× (Optional) Field of View	G20× Magnification	G20× Field of View
Objective 1× *Working Distance 86mm (3.3")*	6.3×	32mm (1.26")	9.45×	20.6mm (0.81")	12.6×	16.0mm (0.63")
	10×	20mm (0.79")	15×	15.8mm (0.62")	20×	10.0mm (0.39")
	16×	12.5mm (0.49")	24×	8.1mm (0.32")	32×	6.25mm (0.25")
	25×	8.0mm (0.31")	37.5×	5.2mm (0.20")	50×	4.0mm (0.16")
	40×	5.0mm (0.20")	60×	3.2mm (0.13")	80×	2.5mm (0.10")

E.I. 203A OCULOGYRAL ILLUSION BOX

Purpose

This item is a 3 dimensional geometric object for the human subject to look at to determine when he is experiencing an oculogyral illusion.

Requirements

General requirements include (1) light weight, (2) vivid color contrast of the object and the background and (3) clearly discernible features and lines in the object.

Hardware Status

This item can be readily fabricated from available materials.

Technical Description

An open cubic structure, 8 cm on a side, was used as a basis for conceptual design definition. The 12 linear elements which make up the open cube will consist of 2 mm diameter tubing. The cube will be placed on a background of contrasting color. Estimated properties are:

Weight	0.2 kg (.4 lb)
Volume	1 dm^3 (0.04 ft^3)
Power	0

Cost

Development	$0.5K
Unit	$0.1K

Development Time: Negligible.

E.I. C132 OSCILLOSCOPE

Purpose

To provide for real time display of electrophysiological signals. The need for the oscilloscope will depend upon the specific experiments being conducted. It is therefore a candidate for an experiment specific equipment item rather than a general purpose equipment item and might be deleted from some carry-on laboratories.

Requirements

Specific requirements have not been determined. Two desirable features of the oscilloscope would be a dual trace capability and a persistent image capability. It was assumed that for the carry-on laboratories (COLs) a bandwidth of 500 kHz and a sensitivity of 1 mV/division (1 mV/cm) would be adequate.

Hardware Status

Commercially available equipment with minor modifications should be suitable. A portable battery powered unit is described below and in the accompanying data sheets. The portable unit was selected because of a number of features which should make it easier to adapt to spacecraft use. It is lightweight and small, and is structurally designed to sustain substantial shock loads (see attached sheet). Also, it is designed to operate off batteries for a minimum of 3.5 hours. If more operating time were required during the carry-on laboratory mission, the batteries could be changed using the 28 volt d.c. spacecraft power supply.

Technical Description

The following properties were based on the use of the Tektronix portable oscilloscope model 214.

Weight	1.6 kg (3.5 lb)
Size	7.6 cm high × 13.3 cm wide × 24.1 cm deep (3 × 5.3 × 9.5 inches)
Volume	2.4 dm^3 (0.09 ft^3)
Power	Batteries

E.I. C132 OSCILLOSCOPE (Continued)

Cost

Estimated costs for a flight version of the oscilloscope are:

Development	$8K
Unit	$2.5K

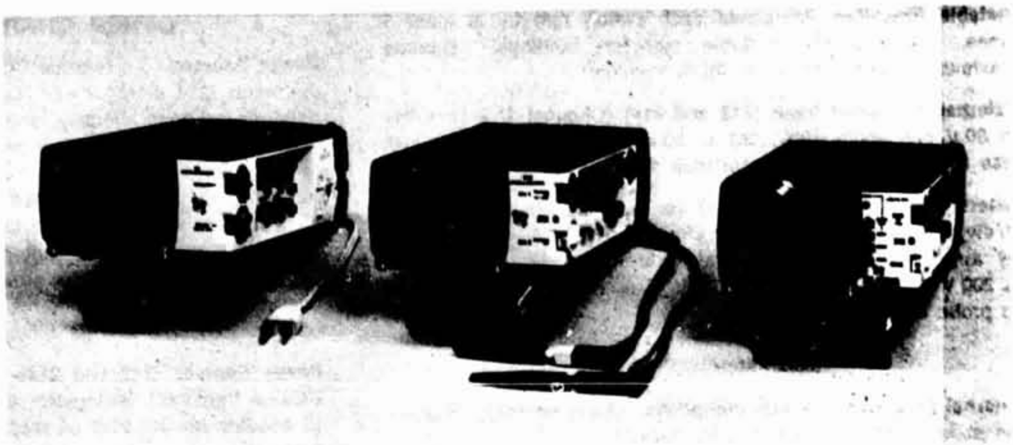
The commercial cost of the Tektronix model 214 is $1K.

Development Time: < 1 yr.

New

PORTABLE OSCILLOSCOPES 211, 212, 214

- 3.5 LB, 3 x 5¼ x 9.5 INCHES
- INTERNAL BATTERY PACK
- 1 mV/DIV to 50 V/DIV
- INTEGRAL 1 MΩ PROBE
- DUAL TRACE (212 & 214)
- STORAGE (214)



The growing 200 series of miniscopes represent a breakthrough in portable oscilloscope design. Fully self-contained, these miniature size, ultra light-weight portables are double-insulated, permitting safer high-voltage measurements. They are built of impact-resistant plastic for applications in severe environments. When not in use, the integral 1 MΩ probes are stored in specially designed compartments. The 212 and 214 probes are color-matched with the vertical deflection controls to minimize measurement error. Clip-on 10X attenuators are available for higher-amplitude applications. A convenient neck strap, which is an included accessory, frees both hands. These miniscopes represent an unequalled value.

Trigger level and slope functions are simplified to one rotary control. With no signal input, an automatic trigger mode provides a bright baseline at all sweep speeds. In the auto mode, when a signal is received, these scopes trigger on the signal. Some applications require an adjustable trigger level. Turning the trigger control clockwise from the auto position allows the user to select any combination of trigger slope and trigger point.

The battery operation, rugged case, and extreme light weight and small size of these scopes make them suitable for a wide range of installation and service applications: Machine and motor controls, audio communication systems, mobile electronics, data transmission systems, office and industrial equipment, frequency translators, computer peripherals, hospital equipment and many others.

In many industrial applications, it is necessary to "float" the oscilloscope. These scopes can be elevated to 700 volts (DC + peak AC) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point. They meet or exceed IEC recommendations for class II instruments.

With the 214, storage is introduced in a miniscope. Storage retains a nonrepetitive or slow moving signal. This allows closer inspection of these signals. In the single sweep mode, the 214 waits for, then records a single event. With this feature, the scope's sweep circuit is armed and will wait for the signal to arrive before it runs. When the signal occurs, the sweep runs once and then waits for a manual reset. When combined with storage, this provides the unique capability of automatically waiting for an event and then storing it for subsequent viewing. The 214 is especially suited for such applications as telephone line signals, electromechanical information, industrial controls and more.

CHARACTERISTICS

Except where indicated, all characteristics apply to all three scopes.

VERTICAL SYSTEM

Deflection Factor— 1 mV/div to 50 V/div in 15 calibrated steps (1-2-5 sequence), accurate within 5%. Uncalibrated, continuously variable between steps to at least 125 V/div.

Bandwidth—DC to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower 3-dB down point AC coupled is less than 2 Hz.

Input R and C—Approx 1 MΩ paralleled by approx 160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div, via attached signal acquisition probes. With optional X10 attenuator adapter, input R is 4.4 MΩ and input C is approx 20 pF.

Insulation Voltage— 500 V RMS or 700 V (DC + peak AC) when operated from internal batteries, with the line cord and plug stored. When operated from AC, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4X line + (DC + peak AC) not to exceed 350 V.

Display Modes (212 and 214)—Channel 1 only, Channel 2 only, or Channel 1 and Channel 2 chopped from 500 ms/div to 2 ms/div of time base, (chopped frequency approx 50 kHz for the 212 and approx 40 kHz for the 214) and alternate from 1 ms/div to 5 μs/div of time base.

Maximum Input Voltage (X1 probe only)— 1 mV/div to 50 mV/div, 600 V (DC + peak AC), AC not over 2 kHz. 0.1 V/div to 50 V/div, 600 volts (DC + peak AC), 600 volts peak-to-peak AC, 5 MHz or less.

Maximum Input Voltage Using Optional 10X Attenuator—1000 volts (DC + peak AC).

Channel 1-Channel 2 Isolation (212 and 214)— 1000:1 (Signals less than 6 divisions).

HORIZONTAL SYSTEM

Time Base (212 and 214)— 5 μs/div to 500 ms/div in 16 calibrated steps (1-2-5 sequence); accurate to within 5%.

Time Base (211)— 5 μs/div to 200 ms/div in 15 calibrated steps (1-2-5 sequence); accurate to within 5%.

E.I. C138 pH METER

Purpose

This meter or sensor measures the hydrogen ion concentration of solutions.

Requirements

To be determined.

Hardware Status

One-g meters are readily available and should be adaptable to zero-g. Modifications will involve 0-g liquid containment techniques, compatible 0-g sensor design, and alteration for use of 28 volt d.c. power. Also, these units could be made to operate in conjunction with a general purpose display console. A typical commercial pH meter with digital readout is shown in the attached catalog sheet.

Technical Description

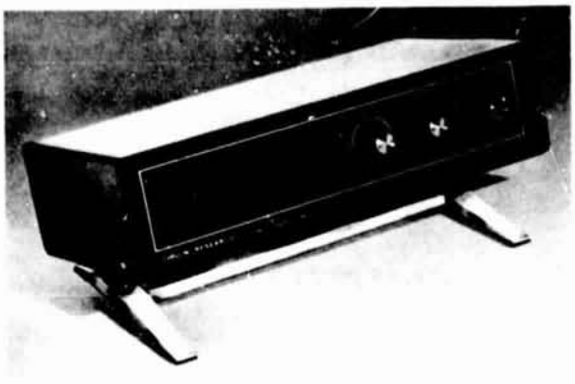
Based on the Orion Model 701, the estimated properties of a flight type pH meter are:

Weight	1.8 kg (4 lb)
Size	32.7 cm wide × 17.8 cm deep × 8.9 cm high (12-7/8" × 7" × 3-1/2")
Volume	5.2 dm^3 (0.18 ft^3)
Power	20 watts (115 volt, 60 Hz)

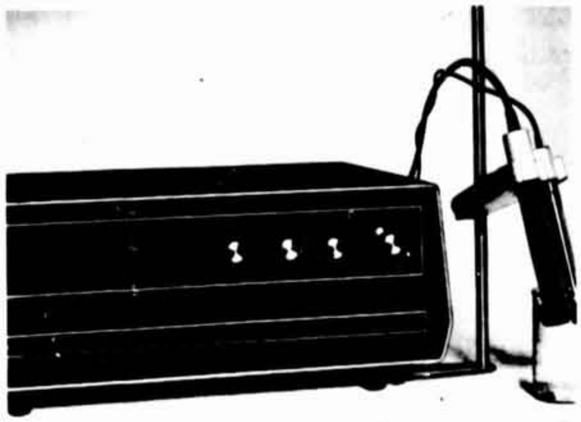
Cost

Commercial Unit	$0.8K
Flight item estimates:	
Development	$77K
Unit	$26.5K

Development Time: 1 yr.



H5795



H5800

H5795
pH METER, Orion Model 701 (Orion 070100) - For general purpose applications requiring measurements in pH and millivolts in the standard and expanded modes. Unit offers bright 4-digit Nixie tube digital display of results; automatic over-range display blanking. Amplifier drift is less than 0.001 pH/°C; recorder output is 0 to ±100mv for full scale deflection. Circuitry permits BCD output. Complete with electrode holder and rod, and shorting strap; without temperature probe or electrodes. Dimensions: $12\frac{7}{8}$"w × 7"d × $3\frac{1}{2}$"h. For operation on 115/230V, 50/60 Hz, 20 watts.

SPECIFICATIONS

Scale	Normal	Expanded
Range	0-14 pH; ±1999mv	2 pH; ±199.9mv
Accuracy	±0.01 pH; ±0.1%mv	±0.001 pH; ±0.1mv
Reproducibility	±0.01 pH; ±1mv	±0.001 pH; ±0.1mv
Temp. compensation	0° to 100°C (Automatic)	
Input impedance	10^{12} ohms	

Order **H5795 - Model 701** . . . . Each **$750.00**

H5796-1
TEMPERATURE PROBE (Orion 070110) - Automatic probe for use with H5795 pH Meter.

Order **H5796-1 - Probe** . . . . Each **$48.00**

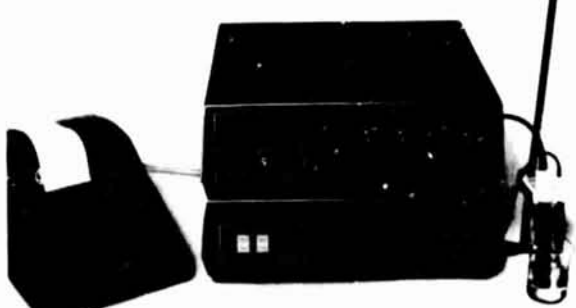
H5800
pH METER, Orion Model 801 (Orion 080100) - For applications requiring a high degree of precision and accuracy; functions with specific ion, pH, or redox electrodes with level of repeatability necessary for research technics. Nixie tube digital display is visible for 30 feet; display time is adjustable from 0.6 to 6.0 seconds, or continuous. Display data is available for BCD output for interface; polarity is indicated along with numerical data. Amplifier drift is less than 0.0002/°C; recorder output is adjustable 0 to ±100mv for full scale deflection. Complete with electrode holder and rod, and shorting strap; without electrode. Dimensions: $18\frac{3}{8}$"w × 12"d × $6\frac{3}{16}$"h. For operation on 115/230V, 50/60 Hz, 40 watts.

SPECIFICATIONS

Range	0-14 pH, ±999.9mv
Accuracy	±0.002 pH; ±0.1mv
Reproducibility	±0.002 pH; ±0.1mv
Temp. compensation	0° to 100°C (Manual)
Input impedance	10^{14} ohms

Order **H5800 - Model 801** . . . . Each **$1095.00**

H5800
H5802-1



H5802-1
DIGITAL PRINTER, Model 851 (Orion 085100) - For use with H5800 Model 801 or H5795 Model 701 pH Meters. Unit prints data on standard adding machine tape with capacity of 4 significant figures; may be set to print data alone, adjustably time-indexed, or sequentially numbered. Program may be interrupted at any time without loss of accumulated elapsed time; unit also responds to external signals from titrators, sample changers, and electrode switches. Dimensions: $15\frac{3}{8}$"w × 12"d × $5\frac{3}{16}$"h. For operation on 115V, 50/60 Hz.

Order **H5802-1 - Model 851** . . . . Each **$1595.00**

E.I. C204 PLUMBING

Purpose

To provide for fluid flow and flow control within the LSPS COLs.

Requirements

Fluid flow rates and line sizes are yet to be determined. In general, it is expected that small lines on the order of 0.64 cm (1/4 inch) o.d. will be sufficient. These lines will be needed for liquid and gas flows within the COL. Fittings, quick disconnects, and valves will also be required.

Hardware Status

Available flight and commercial hardware should be usable.

Technical Description

The following estimates were made for the overall plumbing requirements based upon the use of stainless steel tubing.

Weight	10 kg (22 lb)
Volume	6 dm^3 (0.21 ft^3)
Power	0

Cost

Estimated costs are:

Development	$45K
Unit	$2K

Development Time: < 1 yr

E.I. C149G RADIOISOTOPE TRACERS

Purpose

For injection into organisms to act as tracers.

Requirements

To be determined.

Hardware Status

These chemicals are commercially available. Special packaging designs may be required.

Technical Description

For the COLs the following weight and volume including packaging were assumed.

Weight	0.3 kg (0.6 lb)
Volume	0.5 dm^3 (0.02 ft^3)
Power	0

Cost

Estimated costs are:

Development	$2.4K
Unit	$0.5K

Development Time: < 1 yr.

E.1. C205 RECORDER, STRIP CHART

Purpose

To record various analog voltage signals, including electrophysiological measurements. The records may not be required on all carry-on laboratories (COLs) depending upon the specific experiments.

Requirements

To be determined.

Hardware Status

Required modification on commercial units might involve the ink feed system for 0-g operation and the power supply for use with 28 volt d.c. The following technical data was based on the portable commercial unit built by Gould Inc. and described in the attached catalog sheets.

Technical Description

The Gould Inc., Brush Recorder No. 222 has two analog channels and two event channels. It has a pressurized ink feed system which may be compatible with 0-g operation. It is battery powered and has the following weight and volume.

Weight	14 kg (30.9 lb) (includes 2 kg of recorder paper for up to 30 days)
Size	23 cm wide × 35 cm high × 21 cm deep (9 × 14 × 8 inches)
Volume	16.9 dm^3 (0.60 ft^3)

Cost

Estimated costs are:

Development	$15K
Unit	$5K
Commercial Unit	$2K

Development Time: 1 yr.

BRUSH 222 RECORDER

Now you can get famous Brush quality and performance in a 2 channel general purpose recorder that operates anywhere. The new Brush 222 has an internal battery supply and charger, permitting it to be used away from external power sources as well as from them. Imagine the many additional measurements you can record with this unit – quickly, conveniently, cordlessly. And, when you're not making chart recordings in the self-powered mode, your Brush 222 can serve as a bench or rack mounted unit operating from external a-c or d-c power sources.

The many features of this extremely versatile recorder include:

- Self-powered – 10 second warm-up
- Completely portable
- Internal charger
- Balanced, floating and guarded inputs
- Variable chart speeds
- 1 millivolt sensitivity
- 99.5% linearity, 30 Hz response full scale
- Pressurized ink writing
- Rectilinear trace presentation

The solid state Brush 222 is an internally powered, accurate rugged, lightweight, 2 channel recorder you can use anywhere . . . and get crisp, clear, smudge-free records from a pressurized ink system based on more than 100,000 channels of experience.

This completely self-contained portable recorder has two 40 mm analog channels and two event markers. Other features include built-in preamplifiers with electronic limiters, a measurement range from 1 millivolt/division to 500V full scale, linearity of 99.5% enforced by the exclusive Brush frictionless pen position servo system, frequency response above 30 Hz full scale, and six chart speeds. The external d-c chart drive mode permits variable chart speeds over the full range from 1 mm/sec to 50 mm/sec.

Add to this its internal battery powered operation with only 10-

Carrying Handle

Battery Condition green/red

Chart Speeds 6 speeds of 1, 2, 5, 10, 25 and 50 mm/sec (electrically selected) and "Off"

Event Marker Buttons Right margin and left margin event marker buttons energize event markers when depressed.

Attenuator Steps 1, 2, 5, 10, 20, 50, 100 and 200mV/div.; 0.5, 1, 2, 5 and 10V/div.; "Off"

Sensitivity In X1 switched position attenuator reads directly. It also provides infinite resolution between attenuator steps from 1 to 2.5 times indicated numeral on attenuator dial (above).

Pen Position ± full scale pen position control

Input Terminals plus, minus, and guard. 10 megohms balanced, 5 megohms each terminal to guard

Chart Take Up

seconds warm-up time and its balanced, floating and guarded inputs, and you have in the Brush 222 the most versatile 2-channel recorder available anywhere.

Since both inputs are isolated from each other, from chassis and from the output, the unit can be used with all types of signal sources – grounded, floating or driven off-ground – without affecting accuracy or creating system noise.

The internal battery supply, consisting of two sealed lead-lead dioxide Gould GELYTE* batteries, has a total operating life of up to 6,000 hours when recycled by the recorder's built-in charger. The charger is activated simply by plugging its power input module into an external source of a-c or d-c (depending upon the model selected). The batteries allow continuous operation for up to 12 hours and can be completely recharged in 16 hours – so you can use the Brush 222 all day and recharge its batteries overnight. Since they are sealed, the batteries require no maintenance . . . there are no fluids to add, no liquid levels to check, and no annoying leaks. To eliminate the recording of inaccurate data an automatic ink shut-off is actuated if the battery-voltage falls below a predetermined level.

"Line-assisted" operation allows unrestricted recording time. This is accomplished by powering the charger from an external source at all times, so as to keep a full charge on the batteries.

Thanks to the Brush pressurized ink system, traces are clear, crisp, dry and smudge-free. A disposable ink cartridge holds up to a 1-year supply of ink and can be cleanly replaced in minutes. Whenever the power is off or low, or the chart paper runs out, the writing system stops and ink is withdrawn from the pen tip.

Rectilinear trace presentation, another Brush hallmark, facilitates accurate interpretation of data and waveforms produced by this recorder.

Disposable, self-pressurized ink cartridge. Provides ink supply for about 1 year of normal recording.

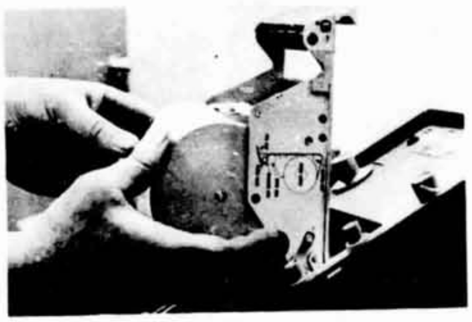
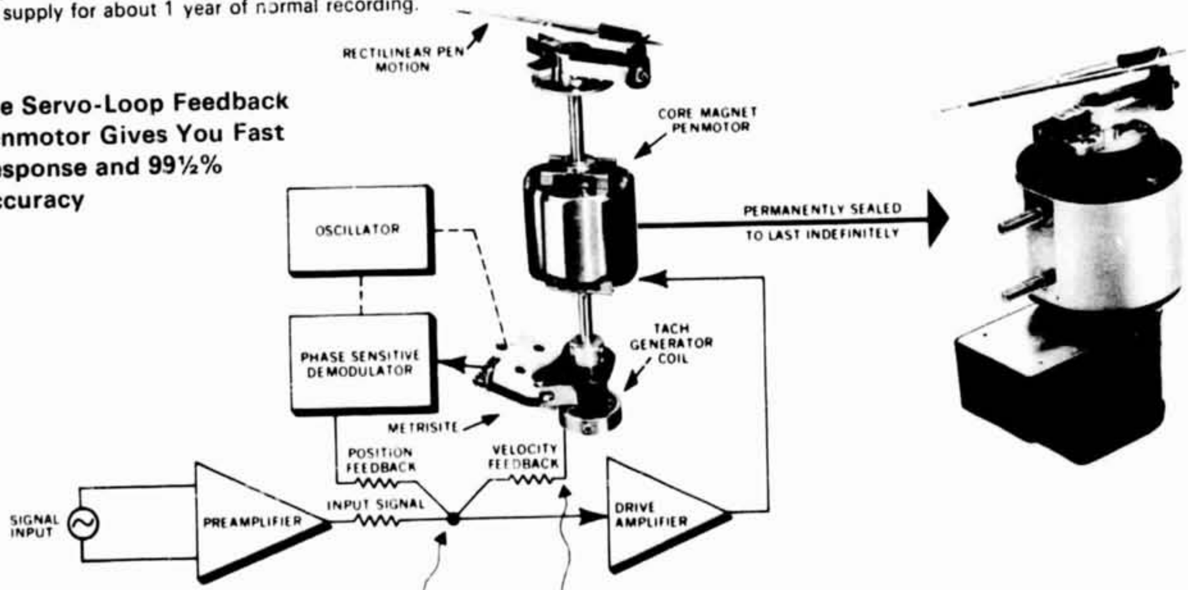


Chart paper roll can be replaced in seconds. Table snaps out and pressure on a lever opens and closes chart holder. Holds a roll 275 ft. of high contrast paper or 400 ft. of reproducible paper.

The Servo-Loop Feedback Penmotor Gives You Fast Response and 99½% Accuracy



±d-c output of Metrisite transducer is proportional to pen displacement from center. It is connected so that input to drive amplifier is always an "error" voltage proportional to difference between where pen is and where it ought to be.

Output of tach generator is proportional to angular velocity of pen shaft, minimizes overshoot on steep wavefronts.

BULLETIN 442-4
NOVEMBER, 1971

BRUSH 222 RECORDER SPECIFICATIONS

Number of Channels	2 analog, 2 event located on left and right margins
Channel Span	40mm (50 divisions)
Frequency Response	At 50-div: Flat within ±2% of full scale from d-c to 30 Hz At 10-div: Flat within ±2% of full scale from d-c to 70 Hz: 3 dB down @ 100 Hz
Non-Linearity	±0.5% full scale
Noise	0.1 division at max. sensitivity and Rs = 50K ohm
Trace Presentation	Rectilinear
Trace Width	0.01″ nominal
Marking Method	Pressurized fluid
Marking Fluid Capacity	1 oz.-28 gm (sufficient for one year of normal recording); replaceable throw-away cartridge
Measurement Range	1 millivolt/chart division to 500V d-c full scale (50 chart divisions)
Attenuator Steps	1, 2, 5, 10, 20, 50, 100, 200 mV/div., 0.5, 1, 2, 5, 10V/div., "OFF"
Maximum Safe Differential Input Voltage	500V d-c or peak a-c either terminal to guard or ground, or between each terminal
Maximum Common Mode Voltage	500V d-c or peak a-c at any attenuator setting between input terminals and chassis ground. 5000 x attenuator setting up to 500V between input terminals and guard.
Input Circuit	Three terminal. Differential floating, balanced to guard. Chassis ground terminal at rear
Input Impedance	10 megohms balanced, 5 megohms each terminal to guard
In-Phase Rejection	80 dB at 60 Hz with 10 kilohm unbalance chassis ground to guard
Signal Limiter	Built-in, adjustable, instant-acting electronic limiters prevent damage to analog pens from off-scale signals
Warm-up Time	10 seconds
Zero Instability	±0.1 div/8 hrs; ±0.1 div/°C from 15-30°C
Gain Instability	±0.1%/8 hrs; ±0.05%/°C from 15-30°C
Chart Speeds	1, 2, 5, 10, 25, 50 mm/sec push-button selected using internal d-c chart drive External d-c chart drive, 0 to 5V d-c input provides stepless adjustment of chart speeds from 1 mm/sec to 50 mm/sec
Chart Speed Accuracy	±1%
Operating Temperature	0°C to 55°C. Recorder within specification between 15°C to 35°C
Storage Temperature	-40°C to +35°C (batteries limiting factor)
Power Input	Self-powered by two lead-lead dioxide 6V batteries (see Ordering Information). Battery output connector on rear of recorder.
Operating Time	8-12 hrs continuous operation without line assistance, depending upon chart speed and signal frequency.
Recharging Time	16 hrs. max.
Battery Life	150 to 500 cycles over one year period.
Weight	26 lbs (11.8 kg).
Outline Dimensions (nominal)	9″w x 13″h x 8″d 13cm x 33cm x 20cm

ORDERING INFORMATION

Standard Recorders	Model Number
All recorders include two batteries, built-in charger, and one adaptor module for charging or "line assisted operation" as listed below:	
For 115 volts, 50-400 Hz, 45 VA	15-6325-00
For 230 volts, 50-400 Hz, 50 VA	15-6325-01
For 12V d-c to 33V d-c, 1 amp	15-6325-02

Accessories	Model Number
Starter Kit Includes 12 rolls Accuchart® paper, gram gage, 2 pen-adjust wrenches, dust cover	11-6250-00
Replacement Kit Includes 12 rolls chart paper, 2 analog pens, 2 event pens, 1 oz. ink cartridge	11-6251-00
Rack Mounting Kit	11-1202-08
Chart Takeup (External)	11-6402-03
Event Marker, Interchannel	11-6221-01
Internal One-second Timer	11-6101-41
Additional Power Adaptor Modules	
For 115 volts	782235
For 230 volts	782233
For 12V d-c to 33V d-c	782237
Cigarette Lighter Cable Assembly (negative ground)	782339

Supplies	Model Number
Chart Paper — Two 40mm grids — 50 divisions	
275 ft (84 meters) Hi-contrast	11-2923-31
400 ft (122 meters) Reproducible	11-2923-43
Analog Pen	11-2823-33
Event Marker Pen	11-2873-20
Ink Cartridge	11-2730-01
Battery	281296

Gould Inc., Instrument Systems Division
3631 Perkins Avenue, Cleveland, Ohio 44114
Telephone (216) 361-3315

GOULD BRUSH

E.I. C153 RECORDER, VOICE

Purpose

A portable recorder for voice recording of experiment results and observations, as well as comments from human test subjects during or following subjective experiments involving man.

Requirements

No special requirements are foreseen. A portable cassette tape recorder with automatic recording volume level control would be suitable. Maximum recording time required is estimated at 30 minutes per day. This recorder is intended merely as a portable supplement to the voice recorders which will probably be aboard the supporting spacecraft.

Hardware Status

Commercial units should be usable in spaceflight with minor modifications. For short missions of the COLs battery recharging would probably not be necessary. If it were, the charger would probably have to be altered to use 28 volt d.c. power, a minor change. A Craig Corp. Model 2605 has been rated by the F.A.A. as acceptable for use in commercial aircraft. This model was used as the basis for the properties assumed below for the COL.

Technical Description

The Craig Corp. Model 2605 has the following properties:

Weight	0.77 kg (1.7 lb)
Size	8.9 cm wide × 14.0 cm high × 3.5 cm deep (3.5 × 5.5 × 1.4 inches)
Volume	0.44 dm^3 (0.015 ft^3)
Voltage	4.5 volts d.c. (batteries)
Nominal operating time on one battery charge: 5 hrs	
Charging time	14 hrs

Cassettes for this type of recorder typically have the following properties:

Weight	45 g (0.1 lb)
Envelope	10 × 6.6 × 1.2 cm (4 × 2.5 × 0.5 inches)
Volume	0.08 dm^3 (0.003 ft^3)
Total recording time: 120 minutes	

To account for cassettes and other equipment such as charger, cards microphone, etc., the following weight and volume was assumed for carry-on laboratories of both 7 and 30 days duration.

Total weight allowance	1 kg (2.2 lb)
Total envelope volume	1 dm^3 (0.035 ft^3)

Cost

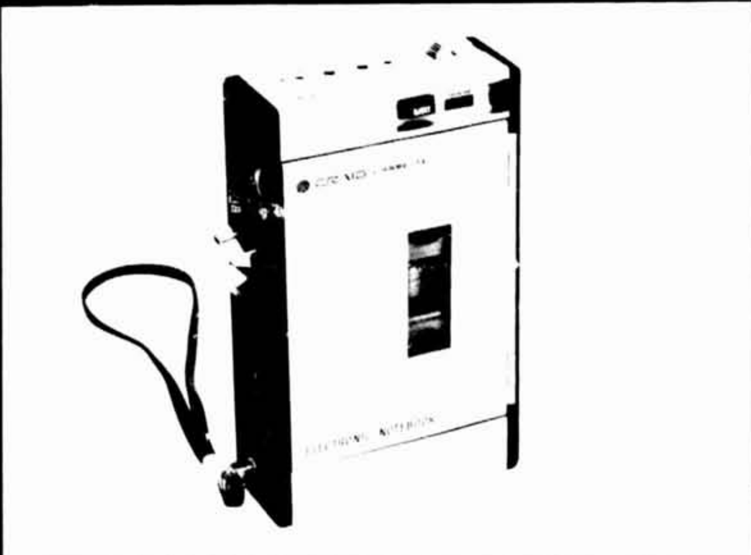
Estimated costs are:

Development	$2K
Unit	$0.3K

The cost of the commercially available Craig Model 2605 is $115 plus $20 for the charger.

Development Time: None

CRAIG® 2605



MINIATURE PORTABLE CASSETTE RECORDER

- "ELECTRONIC NOTEBOOK®" FOR POCKET OR BRIEFCASE
- INSTANT-RESET DIGITAL COUNTER
- BUILT-IN CONDENSER MICROPHONE AND SPEAKER
- LOW-BATTERY WARNING LAMP
- LEATHER-TEXTURED VINYL CASE, AND HAND-STRAP
- POWERED BY STANDARD PENLIGHT BATTERIES, OR OPTIONAL RECHARGE KIT
- PAUSE BUTTON

The CRAIG 2605 is a pocket-size, precision "Electronic Notebook®" with a self-contained microphone and speaker that plays standard size cassette tapes. It weighs slightly more than a pound and is so small it can be tucked in briefcase, pocket or purse, or casually carried by its handstrap. It operates by fingertip controls; has built-in digital counter and low-battery warning light. By using the earphone, you can play the CRAIG 2605 in plane, waiting room, office, school or anywhere without others hearing. And for saving sounds, you can't find another recorder as convenient as the CRAIG 2605 Miniature.

TECHNICAL DATA

Reel Size:	Standard Compact Cassette
Recording Time:	60 min. total with C-60, more with extended-play Cassette
Rewind Time:	180 sec. (C-60) cassette)
Tape Speed:	1⅞ ips
Wow and Flutter:	Less than 0.6% rms
Output Power:	400 Milliwatts peak
Signal/Noise Ratio:	Better than 35 dB
Frequency Response:	200-6000Hz
Transistors:	12
Record System:	Half-track, AC Bias, auto-level control
Erase System:	DC
Inputs:	Microphone, 10 K ohms, −70 dBm
Outputs:	Earphone/Ext. Speaker, 8 ohms
Speaker Size:	2.4 inch
Microphones:	Built-in plus external dynamic, 500 ohms, with remote control switch
Power Source:	3-"AA" size batteries, or optional rechargeable kit
Size:	3½" W x 5½" H x 1⅜" D
Weight:	1.7 lbs. (incl. batteries)
Accessories Supplied:	External Remote Control Microphone, Earphone, Case, Handstrap
Accessories Available:	9215 AC Charger/Battery Kit 9501 Telephone Pickup 9303 Footswitch 9602 Radio Recording Cord 9603 Auxiliary Recording Cord 8211 C-30 Cassette 8212 C-60 Cassette 8213 C-90 Cassette 8214 C-120 Cassette
Guarantee:	Standard 90-day warranty

Description and data subject to change without notice.

A PRODUCT OF CRAIG CORPORATION, COMPTON, CALIFORNIA 90220

E.I. C83 REFRIGERATOR

Purpose

To store perishables to be used in the experiments and specimens taken during the experiments for subsequent ground analysis. This includes biological and chemical materials applicable to biomedical, biological, and life support and protective system experiments.

Requirements

Approximate requirements are:

Temperature	4°C (39°F)
Internal Volume	8 dm^3 (0.28 ft^3)

Hardware Status

Thermoelectric devices for cooling are commercially available and would be suitable for use in the spacecraft laboratory since they do not rely on gravity for their operation. A specially configured refrigerator would have to be designed using these devices.

Technical Description

A thermoelectric refrigerator design concept was used as the basis for the weight volume and power properties listed below. The refrigerator could be constructed of a plastic or aluminum with foam insulation and the thermoelectric cooling modules mounted on one side of the cold chamber. Estimated properties are:

Weight	5 kg (11 lb)
Volume	17 dm^3 (0.6 ft^3)
Power	15 watts

Cost

Estimated costs are:

Development	$59K
Unit	$4K

Development Time: 1 yr.

E.1. C153B SENSORS, MISCELLANEOUS

Purpose

To monitor various parameters associated with the carry-on laboratory (COL) equipment, such as electrical power supply voltage, coolant supply pressures, coolant temperatures, etc.

Requirements

Various sensors and transducers may be used on the COLs to monitor the properties of the resources supplied by the COLs to the experiment equipment. These might include the following:

Voltage	28 volt, d.c.
Amperage	0-20 amps, d.c.
Temperature	278-311°K (40-100°F)
Pressure, water	0-690 kN/m^2 (0-100 psig)
Pressure, gas	0-20.7 MN/m^2 absolute (0-3000 psia)
Pressure, gas	0-207 kN/m^2 gage (0-30 psig)

The output signals from such sensors will be conditioned and fed to the data management subsystem. The values of the sensed parameters may also be displayed at the COL on the numerical display unit.

Hardware Status

Various sensors and transducers have been developed for flight as described in the attached specification sheets from the reference:

> Environmental Control and Life Support '71 Components Specifications, Report No. 18-4-008, Basic Subsystems Module Definition Study, Contract NAS9-6796, General Dynamics/Convair, 17 October 1967.

Similar units could be used for the various COL applications.

Technical Description

Total weight power and volume of 8 sensors are estimated as follows:

Weight	2.0 kg (4.4 lb)
Volume	2.0 dm^3 (0.07 ft^3)
Power	4 watts

E.I. C153B SENSORS, MISCELLANEOUS (CONT.)

Cost

Costs will depend upon whether existing flight type sensors are applicable. Assuming that in most cases they are, the following costs were estimated:

Development	$2K
Unit	$1.25K ea. ($10K for 8 sensors)

Development Time: < 1 yr.

TEMPERATURE SENSOR
(APOLLO P/N 836060 MODIFIED)

PURPOSE

This sensor, which senses the coolant temperature in the molecular sieve (1.62, discharge line, forms a part of the environmental control system instrumentation. The sensor provides an output signal proportional to the sensed temperature.

DESCRIPTION

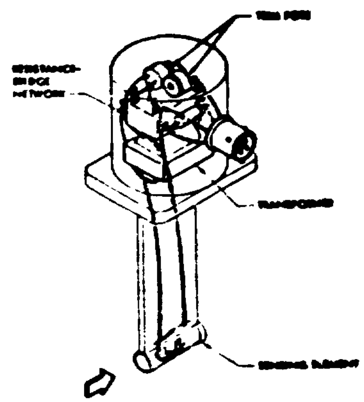
The unit consists of a metal housing containing a coil type sensing element, a resistance-bridge circuit, and a transformer-coupled output circuit. The coil type sensing element, which has a positive coefficient of resistance, forms the measured branch of the resistance-bridge circuit of this unit. The resultant sensor output signal is supplied to an in-flight temperature signal amplifier which amplifies and finally conditions the signal for telemetry purposes or visual display.

PERFORMANCE AND DESIGN DATA

Operating temperature range, °F	50 to 350
Accuracy, °F	±1.5 (±0.59 mv rms)
Output signal	300 cps sq-type wave with voltage proportional to sensed temp. 0 at 20°F and 29.5 mv rms (with 270 ±2.7 ohm load) at 95°F
Output impedance, ohms	500 (max)
Time constant, sec	6.0 (max) (to 63.2% of step temp change in water)
Power dissipation of sensing element, mw	46 (max)
Bridge excitation voltage	2.7 ±0.05 vrms, 300 cps, sq-type waves at 140 ma max effective current
Operating pressures	
Normal, psia	0 to 1
Proof pressure, psi	10 ΔP applied external to unit when installed in duct
Burst pressure, psi	23 ΔP applied external to unit when installed in duct
Weight, lb	0.20

QUALIFICATION STATUS

To be qualified



TEMPERATURE SENSOR
(APOLLO P/N 836058)

PURPOSE

This sensor, which senses the coolant temperature forms a part of the environmental control system instrumentation. Used in conjunction with an in-flight signal amplifier (Item 13.1), the sensor provides an output signal proportional to the sensed temperature.

DESCRIPTION

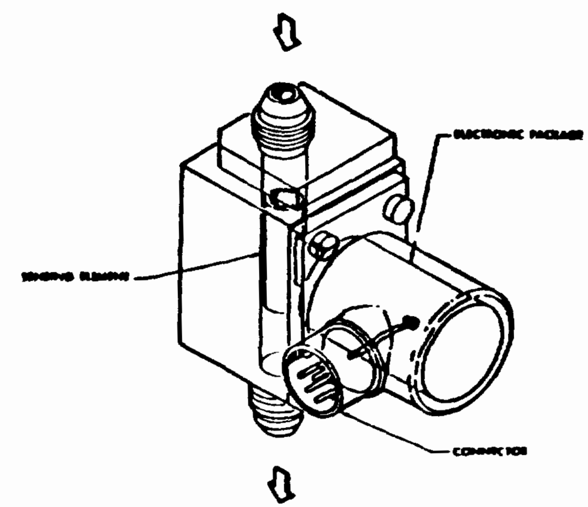
The unit consists of a metal housing containing a coil type sensing element, a resistance-bridge circuit, and a transformer coupled output circuit. The coil type sensing element, which has a positive coefficient of resistance, forms the measured branch of the resistance-bridge circuit of this unit. The resultant sensor output signal is supplied to an in-flight temperature signal amplifier (Item 13.1) which amplifies and finally conditions the signal for telemetry purpose or visual display.

PERFORMANCE AND DESIGN DATA

Operating temperature range, °F	+40 - 130
Accuracy, °F	±3.75 (0.75 mv rms) of sensed temp
Output signal	300 cps sq-type wave with voltage proportional to sensed temp. 0 to -50°F and 29.5 mv rms, (with 270 ±2.7 ohm load) at 100°F
Output impedance, ohms	1300 (max)
Time constant, sec	6.0 (max) (to 6.32% of step temp change in water)
Power dissipation of sensing element, mv	46 (max)
Bridge excitation voltage	2.7 ±0.05 vrms, 300 cps, sq type waves at 140 ma max effective current
Operating pressures	
Max, psig	60 (relative to cabin)
Pressure drop across sensor	0.25 in. water max at flow rate of 200 lb/hr (60 psig and 45°F)
Structural requirements	
Proof pressure, psig	90
Burst pressure, psig	150
External leakage	2.6×10^{-4} lb/hr water-glycol max with 60 psig internal pressure at 70°F
Fitting ends	Per MS 33656-6 Style E (3/8 in. OD tube)
Weight, lb	0.4

QUALIFICATION STATUS

Group I testing of this unit is completed and Group III testing is scheduled, for AAP.



PRESSURE TRANSDUCER
(APOLLO P/N 837016)

PURPOSE

The pressure transducer measures the static pressure in the gas supply line.

DESCRIPTION

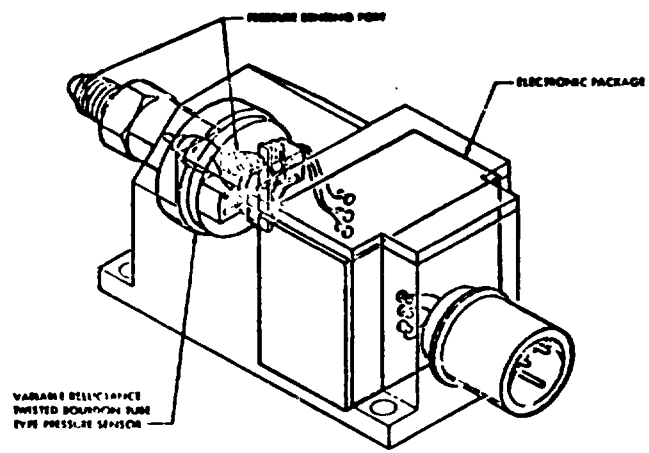
The transducer is powered by the 28 vdc supply of the spacecraft and operates over a range of 0 to 150 psig (referenced to cabin pressure). An electrical signal (0 to 5 vdc) proportional to the pressure of the oxygen for the crew's visual information, via an indicator, and for telemetry data to be transmitted to a ground station.

PERFORMANCE AND DESIGN DATA

Operating range	Gaseous O_2 at 0 to 150 psig and from 0° to 150°F
Accuracy, psig	±3.75 (±0.125 v)
Output signal	Proportional to sensed pressure. 0 v at 0 psig to 5 vdc at 150 psig. Output signal shall not exceed 6.5 v in the event of over-pressurization.
Output ripple, mv rms	Ripple component of output signal shall not exceed 10
Output load, ohms	30,000
Output impedance, ohms	500 (max)
High pressure fitting end	MS 33656-2 (1/8-in. OD tube)
Proof pressure, psig	225 at 70°F
Burst pressure, psia	375 at 70°F
External leakage	6×10^{-4} lb/hr O_2 max with 150 psig internal pressure at 70°F
Electrical power requirements	
Input voltage, vdc	28/SS-1070
Excitation current, ma	25 (max)
Weight, lb	0.5

QUALIFICATION STATUS

The pressure transducer is a qualified Block II Apollo component.



OXYGEN PRESSURE TRANSDUCER

PRESSURE TRANSDUCER (APOLLO P/N 837036)

PURPOSE

The pressure transducer measures the static pressure of the fluid in the discharge duct.

DESCRIPTION

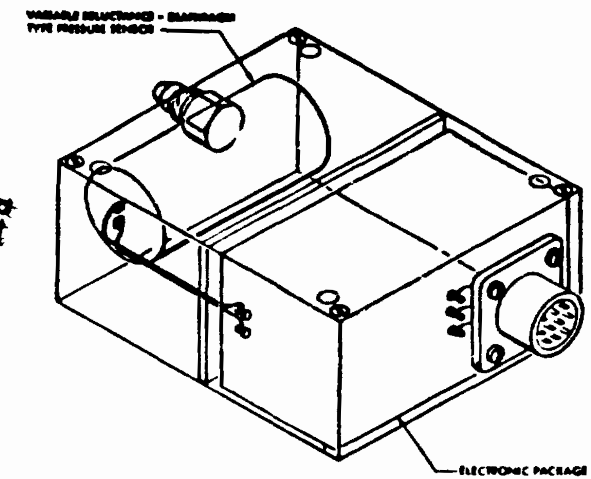
The transducer is powered by the 28 vdc supply of the spacecraft and operates over a range of 0.05 to 0.25 psia. An electrical signal (0 to 5 vdc) proportional to the absolute pressure of the fluid is provided by the transducer. This signal is used for ground checkout, for the crew's visual information, via an indicator, and for telemetry data to be transmitted to a ground station.

PERFORMANCE AND DESIGN DATA

Sensed media	Low pressure gas
Accuracy, psi	±0.005 (±0.125 v)
Time constant of output signal	Minimum
Output signal	Proportional to sensed pressure, 0 v at 0.05 psia to 5.0 vdc at 0.25 psia. Output signal shall not exceed 6.5 v in the event of overpressurization.
Output ripple, mv rms	Ripple component of output signal shall not exceed 10
Output load, ohms	30,000
Output impedance, ohms	500 (max)
Hermetically sealed	No external adjustments
Proof pressure, psia	22.5 at 70°F
Burst pressure, psia	37.5 at 70°F
Sensing port	MS 33656-4 (1/4-in. OD tube)
Leakage	6×10^{-4} lb/hr O_2 max with 20.7 psia external pressure and 14.7 psia internal pressure
Electrical power requirements	
Input voltage, vdc	28 per AiResearch Report SS-1070
Excitation current, ma	40 (max)
Weight, lb	0.65

QUALIFICATION STATUS

This pressure transducer is a qualified Block II Apollo component.



PRESSURE TRANSDUCER

E.I. C206 SHROUD, DEBRIS CONTAINMENT

Purpose

To provide an enclosure for various biological procedures on organisms and specimens for the purpose of minimizing contamination of the cabin with foreign gases and particles including bacteria.

Requirements

For the carry-on laboratories this shroud should be simple and lightweight. It will probably be integrated with the organism holding units.

Hardware Status

Commercial glove boxes similar in function to the debris contaminant shroud are available but are too large and heavy for use in the COLs. The shroud will have to be custom designed for the COLs, using commercially available components. No complicated design problems are foreseen.

Technical Description

Estimated properties of a flexible shroud are:

Weight	4.5 kg (10 lb)
Deployed Volume	0.30 m (10.6 ft^3)
Power	0

Cost

Estimated costs are:

Development	$15K
Unit	$0.5K

Development Time: 1 yr.

C.I. C155B SHROUD, ENVIRONMENTAL

Purpose

To provide a gas tight enclosure around various LSPS test devices for the purpose of containing any gases that might be leaking from these devices.

Requirements

This shroud should be large enough to encapsulate the equipment to be tested on the LSPS COL test benches. The size of this volume is not expected to exceed $0.61 \times 0.61 \times 0.91$ m ($2 \times 2 \times 3$ ft). The shroud should be gas tight but collapsible for purposes of storage.

Hardware Status

Development item. Commercial materials and sealing devices should be usable in the design of the shroud.

Technical Description

The estimated weight and stowed volume of the shroud are:

Weight	4.5 kg (10 lb)
Volume (Stowed)	5.7 dm^3 (0.2 ft^3)

Cost

Estimated at:

Development	$15K
Unit	$0.5K

Development Time: < 1 yr.

E.I. C165 STERILIZER, TOOL

Purpose

To sterilize miscellaneous small metal hand tools such as scalpels, by means of electrical heating.

Requirements

To be determined.

Hardware Status

Existing sterilizers should be usable with minor modifications. The attached catalog sheet contains a description of a commercial Bacti-Cinerator sterilizer. The unit would require alteration in order to use 28 volt d.c. power.

Technical Description

Estimated properties for a flight unit are:

Weight	1 kg (2.2 lb)
Volume	1 dm^3 (0.035 ft^3)
Power	110 watts

Cost

Estimated flight item costs are:

Development	$5K
Unit	$0.5K

The commercial Bacti-Cinerator costs $56.

Development Time: < 1 yr.

B9753

B9753
S/P BACTI-CINERATOR-Sterilizes inoculating loops and needles without the dangerous splattering of pathogenic micro-organisms associated with use of an open gas flame. Ceramic funnel tubing is inert in a carbonaceous atmosphere, and highly resistant to alkaline and other fluxes. Reaches sterilization temperature (1600°F) within 6-minute warmup time. Infrared heat transfers uniformly through entire length of transparent glass tube; incineration of organic matter completed within five to seven seconds. Bacti-Cinerator* opening flares outward into a funnel for easy insertion of loops, needles and culture tube mouths. Any splattering which does occur is confined so that droplets are incinerated in the tubing, not in the open air. Smooth surface of tubing will not abrade loops or needles, and stainless steel perforated guard protects personnel by dissipating heat rapidly. Heavy, cast aluminum base is finished in baked hammerloid enamel, providing stability and handy storage for six needle holders. Economical to operate, Bacti-Cinerator draws less than 0.9 amps. For operation on 115V, 50/60 Hz, 110 watts.
Order **B9753-Bacti-Cinerator** . . . . Each **$56.00**

B9754
ELEMENT, Heating-Replacement for B9753 S/P Bacti-Cinerator.
Order **B9754-Element** . . . . Each **$21.40**

*™-Sherwood Medical Industries, Inc.

E.I. C177 TEMPERATURE PROBES

Purpose

To measure temperatures of organisms, human test subjects, test materials, devices, liquids, soil, environmental chambers, etc. These probes are for general purpose measurements. Experiment specific probes will also be required but are not included in the weight and volume contained herein.

Requirements

Temperature probes with a variety of shapes and temperature ranges will be required. Cylindrical probes of various diameters and lengths are useful for body temperature measurements and immersion measurements. Small disc or "banjo" type probes are useful for surface temperature measurements. The estimated overall temperature range desirable for the probes is 190-375°K (-83 to 102°C, -117°F to 216°F). The probes can be used in conjunction with suitable couplers (E.I. C156) and the numeric display (E.I. C192) for temperature readout.

Hardware Status

Existing commercially available thermocouples or transistor probes should be suitable for use. A typical list of thermistor probes is shown in the accompanying catalog sheet.

Technical Description

The temperature probes are quite light and small. About six would probably be enough for the COLs. These were estimated at:

Weight	0.3 kg (0.7 lb), (total for 6 probes including leads)
Volume	0.4 dm^3 (0.014 ft^3)

Cost

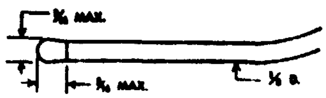
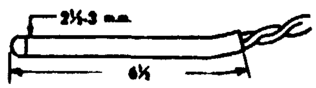
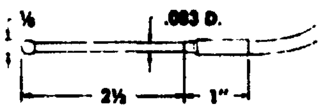
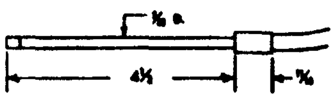
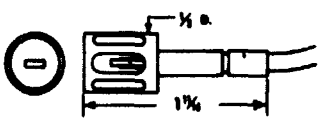
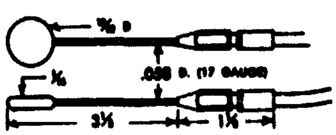
Assuming that commercially available probes could be used, there would not be any development costs. Unit cost for 6 probes would be approximately $0.3K.

Development Time: None

E.I. C177 TEMPERATURE PROBES (CONT.)

INTERCHANGEABLE THERMISTOR PROBES, YSI-For measurement and control of solid surfaces, liquids, gases and semi-solids, for use in any YSI standard indicator circuit, regardless of range covered. Probes follow same resistance temperature curve over the entire usable range of -100° to 300°F (-80° to 150°C); resistance of any probe is precisely known at any temperature within its range. Thermistors change resistance about 5% per °C, leads up to 1000 feet may be used without influencing accuracy of reading. Thermistor probes are capable of very rapid responses to changes in temperature and show much less lag than a glass thermometer.

INTERCHANGEABLE THERMISTOR PROBES

Order Probe		Application and Material	Temperature Ranges	Probe Lead and Connector	Each
T2600	Internal (Esophageal-Rectal) 	Body temperature in humans and larger lab animals Waterproof. Used with longer leads for deep water temperatures. Often buried for subsoil temperatures. Vinyl plastic tip	-110 to 212°F 80 to 100°C	10 foot vinyl covered shielded wire with phone plug	**$15.00**
T2605	Small Animal Probe 	Rectal temperature in small animals such as mice, hamsters, etc. Vinyl plastic sheath and tip	110 to 212°F 80 to 100°C	10 foot vinyl covered shielded wire with phone plug	**$26.00**
T2606	Small Semi-Flexible Nylon 	For insertion into frozen food packages or into softer foods. Also used for rectal and cuvette temperatures	-110 to 212°F -80 to 100°C	10 foot vinyl covered shielded wire with phone plug	**$26.00**
T2610	Tubular 	For liquid immersion applications requiring fast response Excellent oral or rectal probe Immersible only to cap unless specially waterproofed. Stainless steel	-110 to 300°F -80 to 150°C	10 foot vinyl covered shielded wire with phone plug	**$22.00**
T2615	Same as T2610 except diameter of Probe is ⅛"	Smaller diameter provides quicker response but is less rugged	Same as T2610	Same as T2610	**$28.50**
T2620	Air Temperature Probe 	Air temperature in test rooms, incubators, etc. Remote air temperatures. Stainless steel	-110 to 300°F -80 to 150°C	10 foot vinyl covered shielded wire with phone plug	**$28.50**
T2625	"Banjo" Surface Temperature 	Skin temperatures, flat surface temperatures, oral temperatures. Auxiliary temperatures, soil surface temperatures, pipe temperatures. Surface measurement where handle is required. Stainless steel	-110 to 300°F -80 to 150°C	10 foot vinyl covered shielded wire with phone plug	**$28.50**

E.I. C180 TIMER, EVENT

Purpose

To time various experiment procedures.

Requirements

The requirements of this device were assumed to be met by an existing space qualified timer which is described in the following reference:

> "Handbook of Pilot Operational Equipment for Manned Space Flight," Report No. CD42-A/SL-997, Flight Crew Integration Division, NASA/JSC, Houston, Texas, June 1973.

Hardware Status

Available space qualified item.

Technical Description

See the attached descriptive sheet from the reference quoted above.

Weight	0.18 kg (0.4 lb)
Volume	0.2 dm^3 (0.007 ft^3)

Cost

Development Cost	$0
Unit Cost	$0.2K

Development Time: None

E.I. C48 VACUUM CLEANER

Purpose

To collect airborne debris including liquid droplets during experiment procedures.

Requirements

This vacuum cleaner is envisioned to be a small unit with the requirement to suck in and contain small airborne particles. The suction inlet is expected to be manually directed so that a small capacity unit can be effective. The air velocities produced by the vacuum should probably be on the order of five hundred feet per minute in the vicinity (about 28 dm^3 or 1 ft^3) of the vacuuming operation in order to overcome air velocities in the manned compartment which could be on the order of 50 fpm.

Hardware Status

Off the shelf commercial units could probably be used with minor modifications. Modifications might include changes in the type of power used, changes in the collection bag to accommodate liquid droplets, packaging changes, and wiring and materials changes to correspond to fire safety standards. Small portable battery powered vacuum cleaners are available for consideration, in addition to larger units generally powered by 60 Hz, 115 volt a.c. Because of the lack of gravity much less suction than required in ground units will be needed to move particles to the collection site.

Technical Description

The selection and design of this item have not yet been determined. A typical unit is described briefly in the attached catalog excerpt. It is included to indicate the approximate weight, power and size of such units. Without attachments it is estimated to weigh 2.3 kg (5 lb) require 300 watts and occupy 8.5 dm^3 (0.3 ft^3). A flight type unit is estimated at

Weight	2.3 kg (5 lb), including attachments
Power	100 watt
Volume	10 dm^3 (0.35 ft^3), including attachments

Cost

Estimated costs for a flight item are:

E.I. C48 VACUUM CLEANER (Continued)

Development	$38K
Unit	$5.7K

Commercial unit cost - $0.05K

Development Time: < 1 yr.

EUREKA ELEC. HAND-VAC

For Cars, Clothes, Draperies, Furniture
6 Attachments. Disposable Bag. 18' Cord

$23.97 Lightweight Eureka "Whisk" hand-vac makes fast work of cleaning car interiors, fabrics, etc. Has 3 amp., 16,500 RPM motor, plus two-stage blower for deep-down cleaning Contour nozzle concentrates suction. Uses easily changed disposable dust bags. Hose, wand, crevice tool, upholstery brush, dust brush and carrying strap incl. 18 ft. cord. Durable plastic housing, 5 W, 20" L. 115V, 60 Cy. U.L.A. Shpg. wt. 10 lbs.

No. 4H531. (150-AT). Retail $29.95. Each $23.97

E.I. 118I VACUUM MANIFOLD

Purpose

To provide a source of vacuum for LSPS experiment equipment.

Requirements

The item is intended to include all equipment necessary to interface with a spacecraft vacuum system in order to extend the vacuum supply to the COLs. It may include valves, gages, connectors, and fittings as well as the manifold tubing. The vacuum manifold is needed for such purposes as pumping CO_2 out of zeolite beds (molecular sieves), vacuum purging toxic or explosive gases from test units, providing vacuum for thermal insulation, and vacuum drying waste matter. The pumping rates required are not known. However, a manifold with a diameter of 2.54 cm (1 inch) was assumed for purposes of conceptual design definition.

Hardware Status

Hardware suitable for this vacuum manifold system should be available.

Technical Description

The weight volume of this system will be dependent upon the supporting spacecraft configuration, placement of the COL within the spacecraft, etc. Preliminary estimates to be charged to the LSPS COLs are:

Weight	9.1 kg (20 lb)
Power	0
Volume	28.3 dm^3 (1 ft^3)

A part of this weight and volume will be distributed within the spacecraft and not be a part of the COL packages.

Cost

Estimated flight equipment costs are:

Design	\$32K
System	\$5K

Development Time: < 1 yr.

E.I. C193 VENTILATION UNIT FOR SMALL VERTEBRATES

Purpose

The purpose of this unit is to ventilate the small vertebrate holding unit (E.I. 103).

Requirements

The current NASA guideline is to use the cabin atmosphere to ventilate the small vertebrates in order to expose these organisms to an atmosphere similar to that being experienced by the crew. Thus, the ventilation unit must draw cabin air through the small vertebrate common holding unit and exhaust this air to the cabin or to the crew ECS for processing. It has been assumed, that this air would require filtering to remove major contaminants before being exhausted to the cabin

Hardware Status

The unit will have to be designed, fabricated, tested and qualified. However, hardware qualified for space flight or for aircraft applications may be available for use in the design.

Technical Description

The ventilation unit is expected to be quite simple, merely drawing air at cabin composition temperature, pressure, and relative humidity through the small vertebrate holding unit. It will consist of ducting, a blower, valves, a charcoal/particulate filter. The particulate filter will be quite fine, probably filtering out particles in the 10^{-5} mm (0.4 micron) range. The exhaust charcoal/particulate filter will minimize gaseous and particulate contaminants introduced into the cabin of the supporting spacecraft. Further processing of this air by the crew ECS may be used to further eliminate contaminants. The loads imposed upon the crew ECS will be quite small, as estimated below for the case where 8 rats are present.

Parameter	kg/day for 8 rats	% of nominal rate for 1 man
Oxygen consumption	0.14	17%
CO_2 production	0.17	18%

E.I. C193 VENTILATION UNIT FOR SMALL VERTEBRATES (Continued)

The weight, volume, and power properties to account for the above added loads to the crew ECS will depend upon the design of that system. The weight for consumables will probably be no greater than 1-2 kg/day. The following estimates were made for the small vertebrate ventilation unit for 30 days exclusive of any penalties imposed upon the crew ECS.

Weight	9.5 kg (21 lb)
Volume	19 dm^3 (0.67 ft^3)
Power	40 watts

Cost

Estimated costs for a flight ventilation unit are:

Development	$59K
Unit	$21K

Development Time: 1 yr.

E.I. C176 VIDEO TAPE

Purpose

For use with the video tape recorder (E.I. C207).

Requirements

The specific requirements have not been established. An allowance of 6 reels has been included as a baseline. This will provide for 6 hours of video recording, and was assumed to satisfy the MSI requirements for 7 days.

Hardware Status

Video reels for the Sony Videocorder CU-2200 are commercially available and may be usable.

Technical Description

Sony video tape (V-32) is 1/2" wide and 2370 feet long. The following data describes six reels of V-32 tape for 7 days and 18 reels for 30 days:

	7 Days	30 Days
Weight	5 kg (11 lb)	15 kg (33 lb)
Size	19×19×10 cm (7.5×7.5×4")	19×19×30 cm (7.5×7.5×'2")
Volume	3.7 dm^3 (0.13 ft^3)	10.8 dm^3 (.38 ft^3)
Power	0	0

Cost

Development	0
Unit	$0.1K (Total)

Development Time: None

E.I. C207 VIDEO TAPE RECORDER

Purpose

To record crew activity during MSI experimentation.

Requirements

Specific requirements are experiment dependent. The video recorder would be used during MSI experiments requiring subsequent detailed pictorial analysis of crew activity.

Hardware Status

Commercial units are available which provide the desired capability. The Sony Videocorder CV-2200 or equivalent is considered adequate for the requirements. The following specification sheet describes in detail the characteristics of the Sony CV-2200. Conversion from 120 V a.c. to 28 V d.c. power usage might be required.

Technical Description

Estimated properties of a flight unit are:

Weight	22.3 kg (49 lbs)
Volume	50 dm^3 (1.8 ft^3)
Power	80 watts

Cost

Estimated flight unit costs are:

Development	$15K
Unit	$2K

Development Time: 1 yr.

Video recording system:	Rotary two-heads slant-track scanning. Magnetic servo control
Recording signal:	2:1 interlaced composite video signal based on American TV standards (Standard or industrial sync)
Recording time:	60 minutes, continuously, using V-32 tape (2370 ft) 30 minutes, continuously, using V-31 tape (1240 ft)
Tape speed:	7-1/2 ips (inch per second)
Tape width:	1/2"
Video modulation system:	Frequency Modulation
Resolution:	Approximately 220 lines
Video signal-to-noise ratio:	Greater than 40 dB
Video input:	1~3 V (peak to peak), sync negative, 75 ohms at pin 4 of the Monitor Cable Connector (8-pin). Ground return pin 3.
Video camera input:	For SONY Video Camera CVC-2100A, CVC-2000
Video output:	1.4 V (peak to peak) sync negative, 75 ohms, at pin 2 of the Monitor Cable connector (8-pin). Ground return pin 6.
Audio inputs	
Microphone input:	−65 dB, 600 ohms, un-balanced
Audio auxiliary input:	−20 dB, high-impedance, balanced. Alternative feed points pins 7 and 8 of the Monitor Cable Connector (8-pin).
Audio line output:	0 dB, high-impedance, un-balanced Parallel supply points pin 1 of the Monitor Cable Connector (8-pin). Ground return pin 5.
Audio frequency range:	80 10 000 Hz
Audio signal-to-noise ratio:	Greater than 40 dB
Duplicate connector:	Video signal/servo control signal (in and out).
Power requirements:	115~120 V, 60 Hz ±0.4 Hz ac
Power consumption:	80 watts
Dimensions:	18¾"(W) × 11"(H) × 15-3/4"(D)
Weight:	49 lb
Standard Accessories:	Tape V-30 Reel, RH-7V (7" dia) Head-and-Ring cleaner set SONY Oil OL-1K lubricating oil Polishing cloth Splicing tape TV (8-pin) connector AC (2-pin) power cord 12-pin dummy plug
Patent notice:	U.S. Pat. 3,175,034 3,359,365

Design and specifications subject to change without notice.

E.I. C185 VOLT-OHMMETER (VOM) OR MULTIMETER

Purpose

To make electrical measurements and continuity checks. It would be used for experiment measurements as well as maintenance and repair functions.

REQUIREMENTS

Alternating current and direct current measurements will be required within the following estimated minimum and maximum values:

Voltage	1 mV to 300 V
Amperage	1 μA to 10 amps
Resistance	10 ohms to 10 Mohms

The actual ranges needed will be a function of the specific requirements as well as the type of power available on the supporting vehicle. A portable instrument would be desirable for some measurements, but this feature is not mandatory.

Hardware Status

Commercial VOMs should be adaptable for flight. Modifications might include (1) the type of power used, (2) changes in the ranges covered, (3) design alteration needed to survive launch vibrations and loads, and (4) material alterations to meet safety requirements associated with operation in the space vehicle environment. A Simpson Model 360 digital VOM is briefly described in the attached catalog sheet. This meter or one similar to it could probably be adapted for flight.

Skylab carried a digital multimeter kit (VOM) which weighed 1.93 kg (4.25 lb) and might be suitable for use.

Technical Description

The weight, volume and power os the Simpson Model 360 is summarized below:

Weight	2.0 kg (4.5 lb) (with batteries)
Size:	18.3 cmH × 13.7 cmW × 9.5 cmD
	(7.2 × 5.4 × 3.75 in.)
	(not including front panel controls)
Volume	2.39 dm^3 (0.084 ft^3)
Power	0 (battery)

E.I. C185 VOLT-OHMMETER (VOM) (Continued)

Cost

Estimated flight unit costs are:

Development	\$3K
Unit	\$1K

Development Time: < 1 yr.

Simpson 360

DIGITAL VOM

Supplied with test leads, AC line cord, (less batteries) and with operator's manual **$275**

Carrying Case, Catalog No. 00815 . . . . **$19.50**

360 for 220 VAC/50Hz operation (less batteries) **$280**

SPECIFICATIONS

- **MAXIMUM COMMON MODE:**
  - **Voltage:** Floating from earth ground): 600V (DC plus peak AC) from "COMMON" terminal to third wire power line ground terminal
- **DISPLAY:**
  - **Numerical Display:** 3½ digits, 7-segment, 0.33 inch high LED type, non-blinking with storage
  - **Conversion Rate:** 5 readings per second, nominal
  - **Overrange Indication:** Automatic beyond 1999, with lower half of the "1" digit flashing
  - **DC Polarity Selection:** Automatic, with "+" or "−" indication
  - **Analog Display:** 50-0-50 µA moving coil indicator
- **ANALOG OUTPUT:**
  - **Level:** 1 VDC with reading of 1000
  - **Output Resistance:** 100 ohms, nominal
  - **Accuracy:** ±(accuracy of range +2% of meter F.S.)
- **REFERENCE CONDITIONS:**
  - **Temperature:** +25°C ±1°C
  - **Relative Humidity:** 30 to 60%
  - **Atmospheric Pressure:** 575 to 800 mmHg
- **POWER REQUIREMENT:**
  - **AC Operation or Battery Charging:** 117 VAC or 234 VAC ±10% (check rear panel designation) 50 to 400 Hz
  - **Battery Operation:** Four nickel-cadmium "C" size rechargeable cells (not supplied) GE Cat. No. GCT1.5SB or equivalent; each cell rated at 1.25V, 1.5 ampere-hours
  - **Operation Time (continuous with fully charged battery):** 5 hours nominal
  - **Recharge Time (function switch in "BATT CHRG ONLY" position):** 16 hours nominal
  - **Recharge Time (while instrument is in operation):** 30 hours nominal
- **TEMPERATURE RANGE:**
  - **Operating:** 0°C to +50°C
  - **Storage:** −40°C to +60°C
- **WEIGHT** (with batteries): 4.5 lbs. (nominal)
  (without batteries): 4.0 lbs. (nominal)
- **DIMENSIONS:** 7.2" high, 5.4" wide, 3.75" deep (not including panel controls)

DC VOLTAGE

Range	Maximum Indication	Input Impedance	Overload Protection
200 mV	199.9 mV	≥ 100MΩ	350V
2V	1.999V	≥1000MΩ	350V
20V	19.99V	10MΩ	1100V
200V	199.9V	10MΩ	1100V
1000V	1100 (max. input)	10MΩ	1100V

Accuracy: (from +15°C to +35°C): ±(0.25% of reading + 1 digit)
Input Bias Current: 7 nA maximum at reference conditions
Resolution: 100 µV on 200mV range
Overrange Capability: Linear to 250 counts beyond maximum indication (except on 1000V range, where "overrange" is an overload)
Temperature Coefficient: (from 0°C to +50°C): ±(0.025% of reading + 0.1 digit)/°C
Full Scale Step Response: (to rated accuracy): 2 seconds (to 2,000 counts)
Normal Mode Rejection: 35 dB minimum at 60 Hz
Common Mode Rejection: 80 dB minimum at 60 Hz with 1kΩ unbalance
1300 dB min. at DC with 1kΩ unbalance

AC VOLTAGE (Average-sensing, RMS-Calibration Sinewave)

Range	Maximum Indication	Input Impedance	Overload Protection
200mV	199.9mV	1MΩ and 150 pf	350V RMS
2V	1.999V	1MΩ and 150 pf	350V RMS
20V	19.99V	1MΩ and 150 pf	600V RMS
200V	199.9V	1MΩ and 150 pf	600V RMS
600V	600V (max. input)	1MΩ and 150 pf	600V RMS

Accuracy: (from +15°C to +35°C): ±(0.5% of reading +1 digit), 40 Hz to 1.0 kHz
±(1.0% of reading +1 digit), 1.0 kHz to 10 kHz
±(2.0% of reading +2 digits), 10 kHz to 20 kHz
Resolution: 100 µV on 200mV range
Overrange Capability: Linear to 250 counts beyond maximum indication (except on 600V range, where "overrange" is an overload)
Full Scale Step Response: (to rated accuracy): 5 seconds (to 2,000 counts)
Temperature Coefficient: (from 0°C to +50°C): ±(0.05% of reading +0.1 digit)/°C

RESISTANCE

Range	Maximum Indication	Short Circuit Current	Full Scale Voltage	Max. Open-Circuit Voltage	Overload Protection
200Ω*	199.9Ω	420µA	100mV	150mV	250V RMS**
2kΩ*	1.999kΩ	42µA	100mV	150mV	250V RMS**
20kΩ	19.99kΩ	10µA	200mV	10V	250V RMS
200kΩ	199.9kΩ	10µA	2V	10V	250V RMS
2MΩ	1.999MΩ	1µA	2V	10V	250V RMS
20MΩ	19.99MΩ	100nA	2V	10V	250V RMS

Accuracy: (from +15°C to +35°C): 20kΩ, 200kΩ and 2MΩ ranges: ±(0.5% of reading + 1 digit)
200Ω & 2kΩ ranges: ±(0.7% of reading + 2 digits)
20MΩ range: ±(1% of reading + 2 digits)
Resolution: 0.1 ohm on 200Ω range
Overrange Capability: Linear to 250 counts beyond maximum indication, except on 200Ω and 2kΩ ranges
Temperature Coefficient (from 0°C to +50°C): ±(.05% of reading +.1 digit)/°C
Full Scale Step Response: (to rated accuracy): 2 seconds (to 2,000 counts), except on the 20MΩ range, which is 6 seconds
*Low Power Ohms: 1. Maximum Open Circuit Voltage = 150mV
2. Maximum Power Dissipated in Unknown = 100µW
**Fuse Protected

DC CURRENT

Range	Maximum Indication	Full Scale Voltage Drop	Overload Protection
20µA	19.99µA	200mV	3mA
200µA	199.9µA	200mV	25mA
2mA	1.999mA	200mV	1/2 Amp*
20mA	19.99mA	200mV	1/2 Amp*
200mA	199.9mA	200mV	1/2 Amp*
2A	1.999A	200mV	3 Amps
10A	10.00A (max. input)	100mV	10 Amps

Accuracy: (from +15°C to +35°C): ±(0.5% of reading +1 digit) except on 2A and 10A ranges, which are ±(1.0% of reading +1 digit)
Resolution: 10 nA on 20µA range
Overrange Capability: Linear to 250 counts beyond maximum indication (except on 10A range, where "overrange" is an overload)
Full Scale Step Response: (to rated accuracy): 2 seconds (to 2,000 counts)
Temperature Coefficient: (from 0°C to +50°C): ±(0.03% of reading +.1 digit)/°C
*Fuse Protected

H37325 T-821 PRINTED IN U.S.A.

AC CURRENT (40Hz to 10kHz)

Range	Maximum Indication	Full Scale Voltage Drop	Overload Protection
200µA	199.9µA	200mV	25mA
2mA	1.999mA	200mV	1/2 Amp*
20mA	19.99mA	200mV	1/2 Amp*
200mA	199.9mA	200mV	1/2 Amp*
2A	1.999A	200mV	3 Amps
10A	10.00A (max. input)	100mV	10 Amps

Accuracy: (from +15°C to +35°C): ±(1.0% of reading +1 digit) except on 2A and 10A ranges, which are ±(2.0% of reading + 2 digits)
Resolution: 100 nA on 200µA range
Overrange Capability: Linear to 250 counts beyond maximum indication (except on 10A range, where "overrange" is an overload)
Full Scale Step Response: (to rated accuracy): 5 seconds (to 2,000 counts)
Temperature Coefficient: (from 0°C to +50°C): ±(0.05% of reading +.1 digit)/°C
*Fuse Protected

AVAILABLE FROM STOCK AT YOUR LOCAL ELECTRONICS DISTRIBUTOR

Simpson
INSTRUMENTS THAT STAY ACCURATE

SIMPSON ELECTRIC COMPANY
5200 W. Kinzie St., Chicago, Ill. 60644
Telephone (312) 379-1121, Cable: SIMELCO,
Telex: 02-53343

IN CANADA: Bach-Simpson, Ltd., London, Ontario
IN ENGLAND: Bach-Simpson (U.K.), Limited, Cornwall
IN INDIA: Ruttonsha-Simpson Private, Ltd., Bombay-Agra Road, Vikhroli, Bombay

E.I. C213 WASTE STORAGE BAGS

Purpose

To store waste materials from experiments.

Requirements

These bags are intended for use in the small Category C Biomedical COLs. They must accept both solid and moist articles and be hermetically sealing. More specific requirements have yet to be determined.

Hardware Status

Commercially available plastic bags should be usable.

Technical Description

For purposes of conceptual design, the following waste storage bag properties were used. The volume shown is that assumed needed for the bags when filled with waste. The weight, however, is for only the bags.

Weight	0.5 kg (1.1 lb)
Volume (full)	7.8 dm^3 (0.28 ft^3)

Cost

Estimated costs are:

Development:	$0.5K
Unit:	$0.1K

Development Time: < 1 yr.

E.I. C181G WASTE STORAGE CONTAINER

Purpose

To store miscellaneous waste materials for return to earth and disposal.

Requirements

Estimated volume required is 28.3 dm^3 (1 ft^3). A sealed container with liquid and gaseous absorbent material inside is desirable.

Hardware Status

Use existing materials and concepts configured especially for the COL.

Technical Description

Estimated weight and volume are:

Weight	1.0 kg (2.2 lb)
Volume	28.3 dm^3 (1 ft^3)

Cost

Estimated costs are:

Development	$13K
Unit	$0.5K

Development Time: <1 yr.

E.I. C174 WATER TANK, ORGANISM

Purpose

To store water for small vertebrates and plants during the carry-on laboratory (COL) mission duration.

Requirements

The tank capacity was based on the drinking water requirements of 8 rats which is 350 g/day. For thirty days the tank would have to contain 10.5 kg or 10.5 dm^3, and a positive expulsion type of tank would be needed. The tank was assumed to include the necessary plumbing and valves in order to transfer the water to the holding units.

Hardware Status

Flight qualified positive expulsion tank designs may be available in a suitable size.

Technical Description

A spherical tank to contain 10.5 dm^3 of water would be 28 cm (11 in.) in diameter allowing 10% volume allowance for the positive expulsion device. Weight and envelope volume used for the tank and plumbing for conceptual design purposes were:

Weight	12.6 kg (28 lb)
Volume	22 dm^3 (0.78 ft^3) (cubic envelope)
Power	0

Costs

Estimated flight tank costs are:

Development	$56K
Unit	$6.5K

Development Time: < 1 yr.

E.I. C208 WIRE AND CABLE

Purpose

To provide connections for electrode harness assemblies for various physiological measurements, and for calibration, testing and troubleshooting of research equipment.

Requirements

To be used in conjunction with the human physiology kit VCG and ECG sensors.

Hardware Status

Commercial equipment should be usable.

Technical Description

The following estimates have been made for flight equipment:

Weight	2 kg (4.4 lb)
Volume	4 dm^3 (0.14 ft^3)
Power	0

Cost

Estimated costs are:

Development	$2K
Unit	$0.1K

Development Time: None

E.I. C209 WORK SURFACE, AIRFLOW

Purpose

This device provides for holding small items in place in 0-g while working with them without the use of special hold-downs.

Requirements

Estimated preliminary requirements:

Work Surface Size	25 cm × 15 cm (9.8 × 5.9 inches)
Air Velocity	200 fpm

Hardware Status

This item is a conceptual design item.

Technical Description

The airflow work surface is shown conceptually in the accompanying sketch. It is essentially a perforated surface into which airflows for the purpose of holding small items to the surface by means of the differential pressures created. It would probably be integrated into the carry-on laboratory structure. Estimated properties, including the air blower system are:

Weight	5 kg (11 lb)
Volume	6 dm^3 (0.21 ft^3)
Power	75 watts

Cost

Estimated flight equipment costs are:

Development	$16K
Unit	$1K

Development Time: 1 yr.